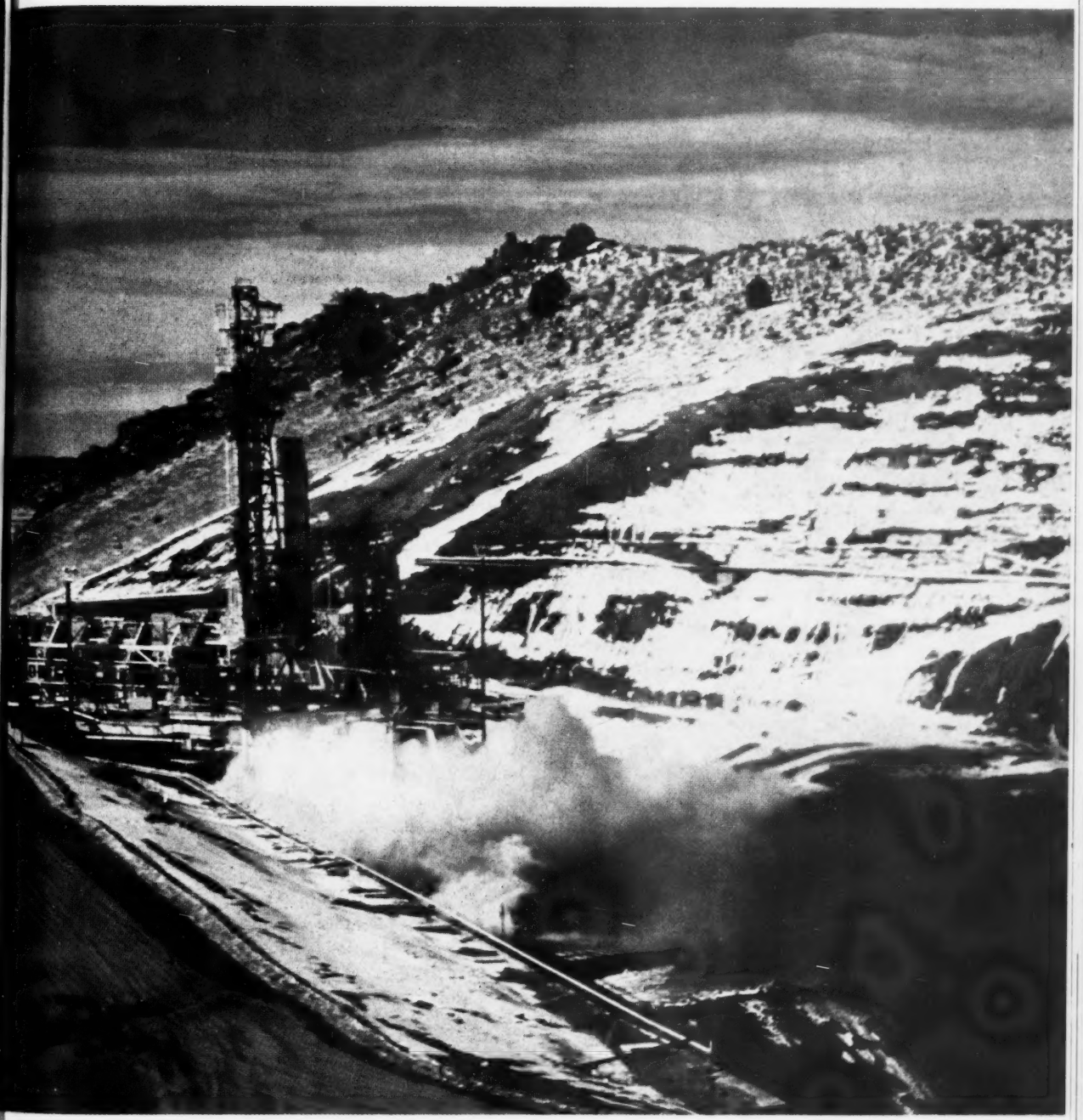
RTMENT OF TECHNOLOGY
AND ERIE COUNTY PUBLIC LIBRARY

Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY

AUGUST 1959



SPACE MEN
OF NASA AND ARPA

Manned Outposts in Space . . . . . Krafft Ehricke
Science, Weapons, and Civilization . . . . . Howard A. Wilcox
Auxiliary Power for Space Probes . . . . . Robert C. Hamilton

MISSILE DESIGN WITH HITCO IN MIND

Missile design is probably the world's most exacting technology relative to the need for high temperature insulation materials.

HITCO is one of the world's leading developers and manufacturers of ultra-performance thermal materials capable of resisting extremely high temperatures, even up to 15,000°F. for short duration!

If you are looking for down-to-earth answers for out-of-this-world high temperature problems, keep HITCO in mind in your Missile Design!

- REFRASIL Materials
- HITCO Metal Blankets
- THERMO-COUSTI Materials
- THOMPSOglas Materials
- ASTROLITE Reinforced Plastics
- HITCORE Structural Core Materials

Call or write us for Capabilities Brochure and complete Technical Data on HITCO Products.

H. I. THOMPSON FIBER GLASS CO. HITCO *1733 Cordova Street • Los Angeles 7, Calif. • REpublic 3-9161*

WRITE OR CALL YOUR NEAREST HITCO REPRESENTATIVE: EASTERN: Tom Kimberly, 38 Crescent Circle, Cheshire, Conn., BR. 2-6544; Fred W. Muhlenfeld, 6659 Loch Hill Rd., Baltimore 12, Md., VA. 5-3135 • **MIDWEST:** Burnie Weddle, 3219 W. 29th St., Indianapolis 22, Ind., WA. 5-8685 • **SOUTHWEST:** Marshall Morris, 2850A W. Berry, Rm. 7, Fort Worth, Tex., WA. 4-8679 **NORTHWEST:** J. L. Larsen, 5757 Oaklawn Pl., Seattle, Wash., PA. 5-9311 • **CANADIAN PLANT:** THE H. I. THOMPSON CO. OF CANADA LTD., 60 Johnston St., Guelph, Ont., TA. 2-6630

Radioplane drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1

RADIOPLANE CREATES FIRST FAMILY OF UNMANNED AIRCRAFT TO TRAIN MEN, EVALUATE WEAPON SYSTEMS, AND SURVEY ENEMY TERRITORY

Radioplane is the world's leading producer of drones and space age recovery systems. As live targets, drones perform as aircraft–then can be recovered by parachute. As evaluators, drones simulate the appearance of the enemy threat while they score our weapon systems' effectiveness. On surveillance missions, drones are zero-length launched, fly cameras, take photos, and return with information within minutes.

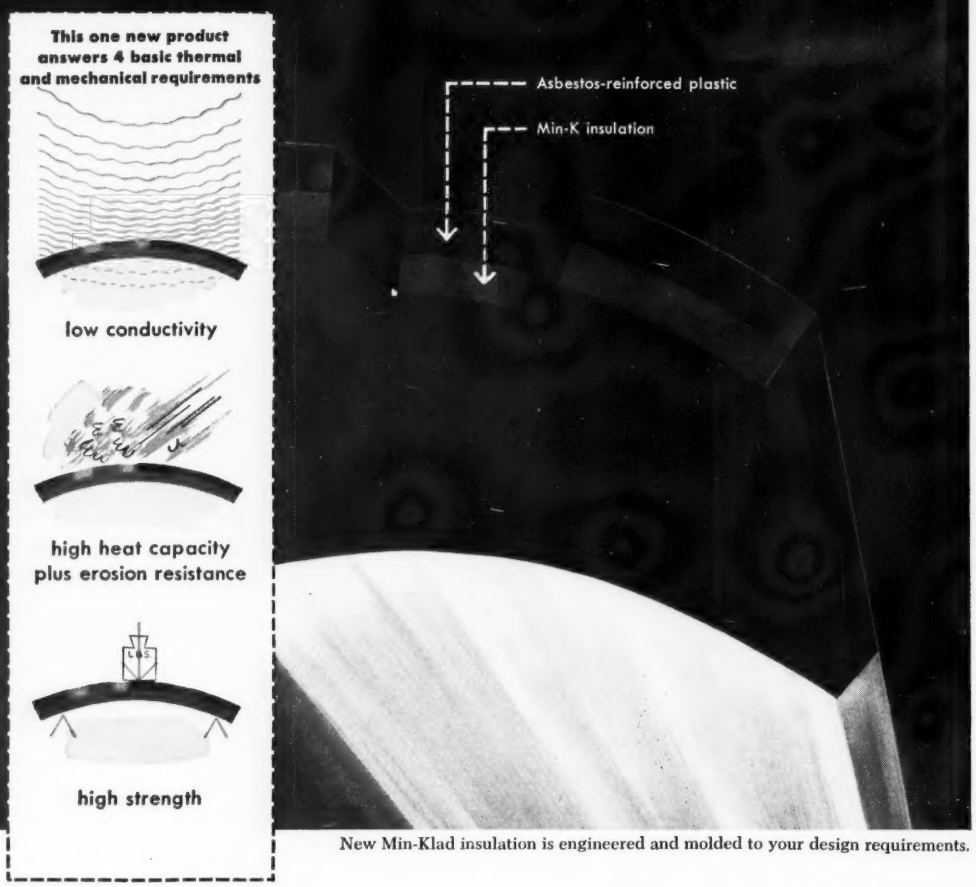
For 20 years Radioplane has led in the production of drones. Radioplane's leadership in the field typifies the years-ahead thinking that continues to produce design concepts for tomorrow, hardware for today – developed, produced, and delivered on time – at minimum cost to the taxpayer.

RADIOPLANE

Van Nuys, California, and El Paso, Texas

A Division of **NORTHROP CORPORATION**

Johns-Manville announces new **MIN-KLAD** Insulation!


This one new product answers 4 basic thermal and mechanical requirements
low conductivity
high heat capacity plus erosion resistance
high strength
Asbestos-reinforced plastic
Min-K insulation

New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface . . . or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY, INC.

August 1959 volume 4 number 8

Editor
IRWIN HERSEY

Technical Editor
MARTIN SUMMERFIELD

Consulting Editor
GEORGE C. SZEGO

Associate Editors
STANLEY BEITLER
JOHN A. NEWBAUER

Art Director
JOHN CULIN

Contributors
Andrew G. Haley,
George F. McLaughlin, G. Edward Pendray,
Jerome M. Pustilnik, Kurt Stehling

Field Correspondents
Eric Burgess, Martin Caidin

Washington Correspondent
William R. Bennett

Contributing Artists
Mel Hunter, Fred L. Wolff

Advertising and Promotion Manager
WILLIAM CHENOWETH

Advertising Production Manager
WALTER BRUNKE

Advertising Representatives
D. C. EMERY & ASSOCIATES,
400 Madison Ave., New York, N. Y.
Telephone: Plaza 9-7460
JAMES C. GALLOWAY & CO.,
6535 Wilshire Blvd., Los Angeles, Calif.
Telephone: Olive 3-3223
JIM SUMMERS & ASSOCIATES,
35 E. Wacker Drive, Chicago, Ill.
Telephone: Andover 3-1154
R. F. and NEIL PICKRELL,
318 Stephenson Bldg., Detroit, Mich.
Telephone: Trinity 1-0790
LOUIS J. BRESNICK,
304 Washington Ave., Chelsea 50, Mass.
Telephone: Chelsea 3-3335
JOHN W. FOSTER,
239 Fourth Ave., Pittsburgh, Pa.
Telephone: Atlantic 1-2977

EDITORIAL

19 The San Diego Meeting . . . . . *John P. Stapp*

FEATURES

20 Manned Outposts in Space . . . . . *Krafft Ehricke*
24 Science, Weapons, and Civilization . . . . . *Howard A. Wilcox*
26 Testing a Titan
30 Auxiliary Power for Space Probes . . . . . *Robert C. Hamilton*
38 The Orbital Post Office . . . . . *Sidney Metzger*
40 A Parametric Amplifier in Space-Probe Tracking . . . . . *William C. Pittman*

SPACE AGENCIES

29 NASA-ARPA Re-entry Detection Research
32 NASA—Men and Giant Rockets . . *John A. Newbauer*
35 ARPA—Military Space Research Agency

ARS MEETING

55 Semi-Annual Meeting Grows in Scope

DEPARTMENTS

4 Astro Notes
14 For the Record
17 Mail Bag
58 ARS News
62 On the Calendar
76 Patents
78 People in the News
88 In Print
90 Missile Market
94 International Scene
96 Government Contracts
100 New Products

104 Index to Advertisers

Print run this issue: 20,517

ASTRONAUTICS is published monthly by the American Rocket Society, Inc., and the American Interplanetary Society at 20th & Northampton Sts., Easton, Pa., U.S.A. Editorial offices: 500 Fifth Ave., New York 36, N. Y. Price $9.00 a year; $9.50 for foreign subscriptions; single copies $1.50. Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122.
© Copyright 1959 by the American Rocket Society, Inc.
Notice of change of address should be sent to Secretary, ARS, at least 30 days prior to publication. Opinions expressed herein are the authors' and do not necessarily reflect those of the Editors or of the Society.

Astro notes

SPACE VEHICLE DEVELOPMENTS

• The AF has further delayed a decision on the award of the Dynasoar rocket glider development contract. AF says the postponement is necessary to complete a new series of technical studies of the program. Competing for the manned space vehicle are teams of contractors led by Boeing and Martin.

• The story of Hansel and Gretel may provide an important lead on how to lick the space feeding problem. A NASA expert has suggested studies of an "edible spaceship," which would utilize foodstuffs as its structural components. Interior bulkheads might consist of fluids and dehydrated foods which would also serve as radiation protection during the early stages of a long space voyage. Fuel tanks might be fabricated of a tough plastic which could be rendered edible through limited processing, etc.

• NASA has asked AEC to develop a "Super-Snap II" power system with 10 times the output of the Snap II auxiliary power system now under development by North American and Thompson Products. Snap II uses a North American nuclear reactor together with a turbogenerator developed by Thompson. NASA wants a more powerful system—one of at least 20-kw capacity—to hitch to electrical propulsion systems for unmanned maneuverable satellites and interplanetary probes.

• Several new names have cropped up in a recent listing of ARPA space projects: Samos, Somnium, and Notus. ARPA won't identify the first two except to say they are tags for in-house projects which have been underway for some time. Notus (Greek for "south wind") is the designation for ARPA's total effort in communications satellite development as projected through 1965, including the "stationary" equatorial orbiters.

• ARPA has ordered a "simple evaluation" for the Thor-Hustler booster used in the Discoverer satellite program because the failures of Discoverer IV (insufficient speed) and Discoverer II (incorrect angle of injection) appear to be related. No major engineering modifications are contemplated, but there may be revisions in the programing of the booster vehicle.

• The outline of NASA space probe power requirements which appeared on page 47 of the July ASTRONAUTICS represents, it was learned at the ARS Semi-Annual Meeting, an early and tentative planning version of missions and power needs. In order to meet the mission flight dates, revised system optimization has been required by the state-of-the-art in payload weight capability, communications, attitude control, and space power sources. In addition, some revisions of missions and flight dates are under consideration. The average power requirement for most interplanetary missions is now estimated to be 200 watts, with 600 watts required for the Venus satellite and landing and the soft lunar landing.

MAN IN SPACE

• With the House chipping away at its budget, NASA held a conference for the press at Langley Research Center at which it was revealed that the agency is waiting on its prime contractors to produce hardware to continue with Project Mercury development and testing; that the Astronauts are well along in their indoctrination and training; that Jupiter boosters may be phased out of the Mercury program; and that the first Atlas to carry a manned capsule will be sent into orbit.

• McDonnell Aircraft's Mercury contract calls for 12 capsules, 12 ablation and six beryllium heat shields, six escape and six retrorocket systems, various adapters, and a mockup of the capsule system.

• The Russians claim to have sent two dogs and a rabbit to an unrevealed height in the upper atmosphere with a powerful single-stage rocket, and brought them back alive and in good condition. "It won't be long now before we see people flying into space," announced Gregory Krushchev of the Soviet Academy of Sciences. The Russians gave the weight of instruments and animals as over 4400 lb.

• Discoverer IV, carrying equipment expected to be used in later launchings with monkeys, failed to orbit. If orbit had been achieved, the AF had planned to try for an aerial catch of the re-entry capsule near Hawaii.

• NASA has awarded Grumman Aircraft Engineering Corp. a contract to study Mercury capsule recovery by ship and aircraft.

• Radar detection of the ionized detritus from a re-entering vehicle is the goal of a NASA program in cooperation with Lincoln Labs (see page 29).

• The House Select Committee on Astronautics and Space Exploration has ordered an inquiry into published reports of low morale among the Mercury Astronauts, presumably because of loss of flying time (and $200 a month in pay) in high-performance jet aircraft while undergoing training.

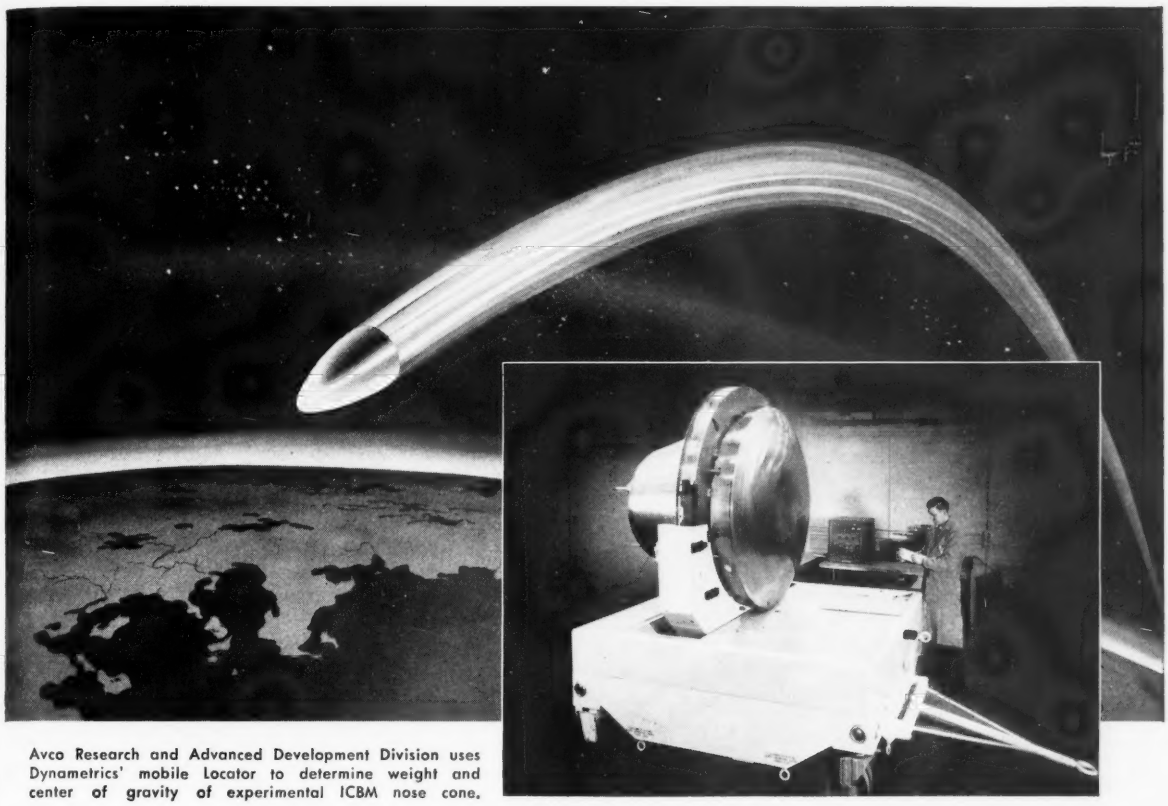
SPACE SCIENCE

• NASA is scheduling two space probes and eight satellites (including Vanguard) to support its space sciences program this calender year, to be followed by four space probes and six satellites in calendar 1960. Excluded from the planned vehicles are all space shots of an applied nature, such as the Mercury man-in-space project, and communications and meteorological satellites.

• Workhorse of NASA's space sciences program next year will be the Thor-Delta vehicle, a modification of the Thor-Able incorporating the Titan radio-inertial guidance system for greater accuracy and a substantially larger spin table for the third-stage rocket and payload. NASA hopes to place up to 500-lb payloads in circular orbits with the Delta, which will have a cost of somewhat more than $2 million apiece.

• The Thor-Delta program will get underway late this year or early next year with an attempt to launch a 100-ft aluminized mylar sphere in a 1000-mile orbit for a passive communications relay experiment involving the transmission of high-frequency radio signals between JPL's 84-ft dish at Goldstone and a radio telescope reportedly to be located in New Jersey. The communications sphere is the first of 12 projected Delta payloads.

• Second Delta shot will be a lunar hard-landing payload, which will utilize a retrorocket system to reduce the terminal velocity of the payload by at least half on its fall to the moon, or to 3000 fps or less. It will be equipped with rugged instruments and telemetry to withstand the shock of landing.



Avco Research and Advanced Development Division uses Dynametrics' mobile Locator to determine weight and center of gravity of experimental ICBM nose cone.

PUTTING THE BUSINESS END . . . IN BUSINESS

The nose cone or "business end" of an ICBM will disintegrate from the violent shock and 15,000°F temperature that builds up as it plunges back into the dense air surrounding the earth's surface, unless re-entry can be made at the optimum attitude.

Dynametrics has developed a Weight and Center of Gravity Locator for precise determination of weight of the nose cone and CG components along its 3 principal axes as part of the procedure for insuring that the nose cone will be aligned properly as it re-enters the atmosphere. Avco Research and Advanced Development Division, developers of re-entry vehicles for the Air Force Titan and Minuteman ICBM's, are successfully using a Dynametrics Locator to put the "business end" in business.

The Dynametrics Weight and Center of Gravity Locator combines the accuracy of a laboratory static balance indicator with the ruggedness required for field usage. At the flip of a switch, this unique instrument gives easily legible digital readout of weight and center of gravity for two axes of the nose cone. Then, by rotating the cone 90°, another reading is obtained in the same manner along the third axis. Measurements are independent of gravity variations since the instrument operates on the principle of gravity moment balance rather than spring deflection.

Capacity of the Locator is more than 4,000 lbs. with an indicator resolution of tenths of pounds. The Locator is mobile by air transport and is adaptable to quick field setup. This instrument can be used by untrained personnel — a most significant feature with reference to the operational phase of missile work.

The Weight and Center of Gravity Locator is a typical example of Dynametrics' capabilities in solving difficult force and pressure measurement problems. Write for technical information about any one of the Dynametrics' three areas of interest: *Special Services and Equipment* such as Wind Tunnel design, CG Locators, Strain Gage Balances, and Missile and Aircraft Models: *Weighing, Proportioning, and Batching Systems; Pressure Measuring Instruments* such as Manometers, Primary Presure Standards, Digital Barometers, etc.

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

DYNAMETRICS CORPORATION

Northwest Industrial Park • Dept. 17 • Burlington, Mass.

• Following at approximately 60-day intervals will be the following Thor-Delta launchings: The 270-lb Tiros meteorological satellite (No. 3); space probe for cosmic ray measurements within 30,000 miles of the earth (No. 4); backup for lunar landing experiment (No. 5); 100-ft communications sphere in a 1000-mile orbit (No. 6); solar spectroscopy experiment (No. 7); elliptical orbit payload for study of the atmospheric structure (No. 8); backup for communications satellite (No. 9); geodetic satellite for gravity measurements (No. 10); ionospheric experiment (No. 11), and an active TV relay satellite (No. 12).

• Vanguard I (1958 Beta) is still yielding significant data. It now appears that the sun-powered satellite has picked up a potential of several thousand volts in its orbital journey, and that this potential is providing a special electrostatic drag on the satellite which is distinguishable from atmospheric drag effects. Prolonged measurements of the electrostatic drag may serve to spell out the amount and kind of electrical charge, but NASA scientists believe they can get the same information more readily with specially-instrumented satellites and probes.

• A nine-man delegation of British space scientists led by Harrie S. W. Massey, Univ. of London, has outlined to NASA a dozen possible space experiments for which it is seeking U.S. rocket boosters. The experiments include precise measurements of the ozone content of the atmosphere, the relative population of heavy versus light atoms, the electrical density of the ionosphere, and radio-telescope observations. It is understood that NASA has informally offered to make several vehicles available to the British—presumably including the Scout solid-propellent booster which has a payload capability of 100 to 150 lb.

• Canada has offered to contribute 20 man-years of engineering time to the design, development, and construction of a "top-side sounder" to conduct ionospheric research studies. Using a variety of radio frequencies and responding to a ground command, the satellite should be able to report on the density and condition of the ionosphere, particularly in the auroral regions, which frequently experience profound radio communications difficulties.

• American and Russian astrophysicists both speculate that Jupiter's low-frequency radio emissions arise in an ionosphere. V. V. Zhelezniakov of Gorki State Univ. believes fluctuations in the layers of this ionosphere generate Jupiter's emissions, and that signals from Venus may arise in the same manner. U.S. physicists have also suggested that higher-frequency signals from Jupiter may arise in a radiation belt a million times more intense than that of earth.

• Republic Aviation will correlate the large mass of data obtained on Sputnik II for AFCRC and attempt to formulate what would have been the best method for predicting its orbital characteristics. The study is aimed at providing an inventory system for satellites.

• NASA has awarded Hughes Aircraft a $200,000 contract for a 30-lb atomic clock. Based on a gaseous maser, the clock will be used in a satellite experiment to test the general theory of relativity. Under construction at Hughes Research Lab under the direction of Harold Lyons, inventor of the first atomic clock, it will operate for 500 hr at a counting-rate accuracy of 3 in 100 billion sec.

• Surprise feature of the Soviet Exhibition of Science, Technology, and Culture in New York's Coliseum was the unannounced showing of a full-scale model of the last stage of Mechta, the cosmic rocket. With fairing, the stage is roughly 10 ft in diam and 20 ft long.

• NRL has received a $250,000 NSF grant to make ultraviolet and X-ray emission studies of solar flares. Long active in this area, NRL will use Nike-Asp vehicles having as instrumentation X-ray detectors for 8–20 and 44–60 Å; Geiger counters to measure X-rays at 1–10 Å; scintillation counters sensitive to hard X-rays in the 20–5000 kv range; and ion chambers sensitive to helium emission at 584 and 314 Å.

• With an NSF grant, and in cooperation with NASA, the Kitt Peak National Observatory is doing design studies of a large telescope for use from an earth satellite. Engineering considerations indicate that this telescope might have a 50-in. aperture and a functional lifetime of 5 to 10 yr.

• Goodyear Tire and Rubber has developed a tire made entirely of wire, something in the form of the wire burnishing wheels used on lathes. It withstands temperatures of 1000 to 2000 F, and has load-deflection characteristics similar to those of pneumatic tires, but with much higher rolling friction. Such a tire might be used on re-entry vehicles or on a moon car.

• New loftings of a 12-in. telescope and television equipment to aim and focus it are scheduled to take place in the Stratoscope program, which is jointly sponsored by NSF and ONR. Studies will again be made of the sun.

• ARDC recently began a new series of instrumented-balloon launchings. Personnel from Holloman launched a 128-ft-diam balloon carrying a gondola with 100 lb of instruments designed to reach 100,000 ft. The instruments, designed by AFCRC and Martin's RIAS subsidiary, are intended to distinguish between primary and secondary cosmic particles.

• ARPA approved a three-month extension of the 10-month feasibility study for a nuclear-bomb-propelled rocket being made by General Atomic Div. of General Dynamics.

SPACE ORGANIZATION

• In a move aimed at strengthening the Civilian-Military Liaison Committee which coordinates NASA and ARPA space programs, President Eisenhower revised the committee's charter to permit it to mediate civilian-military space disputes on its own initiative. Previously, CMLC could only act in a dispute if requested by one of the parties. As a result, it little more than funneled NASA booster requirements to the military services.

MISSILES

• Titan, very successful in its first free flights (see page 26), appears on tap for its first major flight over the Atlantic. Also, a modified Titan first stage, Army announced, will constitute the Saturn second stage.

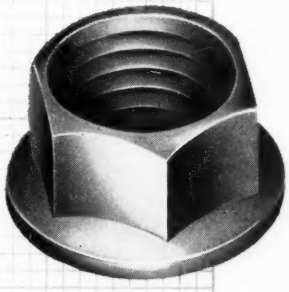
• AF is negotiating a contract with Martin-Orlando to develop a new version of the Bullpup air-to-surface missile equipped with a television-eye guidance system. While much more expensive than the radar-controlled Bullpup now in Navy operation, the TV guidance system should permit greater flexibility. For example, an aircraft launching the TV Bullpup need not follow it into the target; instead the pilot can take evasive action immediately after launch, at the same time di-

Again...

ESNA gives the design decision to the engineer

If your major consideration is...

...WEIGHT REDUCTION

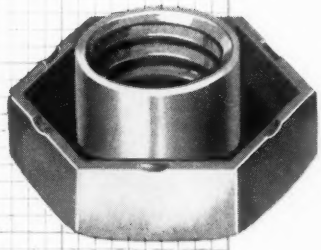


Type LH3324 (160,000 psi)

THIS NEW DESIGN is ESNA's recommendation for applications where space and weight reduction are primary needs. Meets MIL-N-25027; reduced wrenching dimensions permit more efficient centerline bolt design; wrench heights carefully engineered to assure satisfactory assembly line performance. Materials: carbon steel, AMS6304 alloy steel and A286 stainless steel.

wt in lbs per 1000	Screw Size # 4	# 6	# 8	# 10	¼"	5/16"	3/8"	tensile rating
LH3324	.2	.6	1.3	1.4	2.9	5.4	7.3	160,000 psi
NAS679	.9	1.7	2.4	2.6	4.6	6.4	8.6	140,000 psi
AN365	1.4	2.6	4.2	5.0	9.0	12.0	18.0	140,000 psi

...USE OF NAS STANDARD HARDWARE

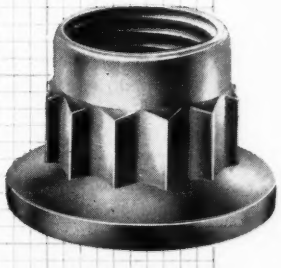


Type LHTE-TM (NAS 679 140,000 psi)

This complete line of low-height, lightweight NAS 679 hex nuts has been designed and produced to ESNA's exacting quality standards. Qualified to MIL-N-25027. External-internal wrenching surfaces for easy installation in limited access areas. Sizes 4-40 through 7/16-20. Alloy steel for temperatures to 550°F; A286 stainless steel for temperatures to 900°F and nonmagnetic applications.

ESNA offers a complete line of ALL NAS types of self-locking nuts, including standard and miniature anchors, floaters and gang channels.

...ULTRA-HIGH TENSILE AND FATIGUE PERFORMANCE



Type LH3393 (220,000 psi)

Specify types LH 3393 and LHEB 220 for the utmost in high tensile and fatigue-life performance. Highest strength-to-weight of any available double hex design. Cold-formed from alloy steels; sizes ¼-28 thru 1". For use at temperatures to 550°F.

Other lightweight 12 point nut series are available in several tensile capacities and materials for service at temperatures to 1300°F.

Fit the fastener to the application from the only complete line of self-locking fasteners

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. S36-899, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey
Please send me the following free fastening information:

☐ Complete dimensional and performance data of the new type 3324 nut.

☐ Visual Index: A complete pictorial representation of all standard Elastic Stop nuts.

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____

DEPARTMENT OF TECHNOLOGY
BUFFALO AND ERIE COUNTY PUBLIC LIBRARY

recting the missile by following its course on a small TV screen in the cockpit of his aircraft.

• Introduction of the Atlas-D ICBM to operational status has been delayed at least 60 days as a result of a string of five straight Atlas failures in Cape Canaveral test flights. The difficulties appear to be of a random character, prompting some observers to conclude that Atlas is suffering from transition to production status after being coddled for two years as an R&D item.

• Atlas difficulties led Defense Secretary Neil McElroy to comment that the Russians are having "serious trouble" with their own ICBM. He was evidently referring to the long "dry spell" in Soviet ICBM tests—May 1958 to March 1959. During this period, the Soviets fired several abortive satellites and lunar probes, as well as the successful Mechta probe, but apparently no long-range ballistic missiles. Since March, however, the Russians have resumed testing at an accelerated rate of four or five ICBM's a month. The year's suspension of Soviet ICBM tests has led some observers to conclude that the Russians found major ICBM redesign necessary—perhaps a scaledown of the size of their initial ICBM vehicle.

• The Administration effected a compromise in the interservice quarrel over the respective merits of Nike-Hercules and Bomarc air defense missiles which will keep both weapons in the program but in reduced numbers. Congress grumpily went along with the new "master plan," supposed to save $1.5 billion over the next several years, but added $137 million to the Nike-Zeus anti-missile program to emphasize its desire for speedier progress on newer defensive systems.

• Disregard reports that Soviet satellites in Eastern Europe are bulging with 700-mile and 1100-mile ballistic missiles. Despite scare stories about Soviet rockets secretly positioned in the satellites, U.S. intelligence has no information of the existence of such weapons in forward positions. They evidently remain the exclusive property of the Red Army. This means the Russians still cannot reach forward U.S. air bases in Spain and Morocco, and that many U.S. bases in England are beyond the reach of Soviet mid-range weapons.

• The third Polaris test rocket of operational size and shape blazed through a successful freeflight test from Cape Canaveral, with first data analysis indicating good general performance, stage separation, and structural integrity. And on Long Island, N.Y., the Navy and Sperry Gyroscope christened a shorebased replica of the semiautomatic inertial navigation system (SINS) for Polaris submarines. Also, ship-launching of Polaris should take place this month.

• In addition to the $161 million in contracts Raytheon recently announced it had received for continued production of the Hawk ground-to-air missile, the company has added more than $20 million in orders from the Boston Ordnance District. The Army and Raytheon have selected Red River Arsenal, Texarkana, Tex., as the final assembly site for the missile.

• France, Italy, Germany, Belgium, and Holland have signed an agreement with the U.S. to produce Hawk for NATO use. Pooling their own monies and facilities, each country will make some part of the missile and interchange parts to produce complete birds. This agreement may set a pattern for future foreign negotiations for U.S. weapons.

• An advanced version of Terrier, now in production at Convair-Pomona, is expected to become a major weapon in the Navy's missile arsenal, arming several carriers and cruisers and about 20 frigates. The new Terrier appears to have shorter time to target, longer range, and variable thrust, controlled by the guidance system, to adapt missile speed to target speed and maneuver.

• Construction of 9 Atlas single-missile launching sites dispersed in a 60-mile radius about Cheyenne, Wyo., will begin this fall, at an estimated cost of $20 to $30 million apiece. Four multiple-pad launching sites are now under construction at various points about 20 miles from Cheyenne, at a cost of about $100 million.

MISSILE RANGES

• Navy is pushing hard for expansion of the Pacific Missile Range in the form of an equatorial launching site. The sailors have suggested Manus Island (in the Admiralties) or Kapingamarangi (U.S. Pacific Trust Territory) as possible sites. Both are within two degrees of the equator. Critics of the scheme claim it would cost a minimum of $100 million to build and half that in annual operating costs. Furthermore, they see no requirement for such a site in the next three to five years, and argue that it would cost less in the long run to continue at Cape Canaveral. A NASA committee headed by Dr. John Hagen is studying the problem and expects to have an answer sometime in the fall.

• Army is building Nike-Zeus flight-test facilities at Kwajalein Island for realistic target practice against Thor-Able nose cones to be fired by the Air Force from Johnston Island. The soldiers eventually expect to try out the Zeus anti-missile on Polaris nose cones fired by Navy ballistic missile submarines. First Zeus firings may come at Kwajalein in 1962.

• Navy reports it is building an ICBM "bullseye" 70 miles northeast of Wake Island, and another between Wake and Eniwetok, to measure the accuracy of ICBM shots fired from Vandenberg AFB, Calif. The ICBM targets use underwater hydrophones to measure precise impact points. A similar installation has been established at Kaneohe Bay, Hawaii, to report IRBM shots.

TRACKING FACILITIES

• DOD announced the start of construction of two important new satellite tracking and data acquisition facilities—presumably in conjunction with the Sentry reconnaissance satellite program. Similar in design and operation, the facilities are located at New Boston, N.H., and Donnelly Flats, Alaska, near Fairbanks. They will track, determine, and predict orbits as well as receive and process satellite telemetry information, the Pentagon said. The New Boston site consists of eight buildings and will house 350 personnel, while Donnelly Flats will require about 200 persons. The decision to go ahead with construction of elaborate ground installations indicates that Sentry will utilize both recoverable data capsules as well as televised data transmission to deliver its reconnaissance information.

• Additional tracking facilities may be established for the ARPA-AF Discoverer program and other military projects. The tracking ship "Joseph E. Mann," 950 miles south of Vandenberg AFB, Calif., may be replaced by a permanent installation on Mexico's Clarion Island. Another installation has been mentioned for possible location at

AN ENTIRELY NEW CONCEPT IN PRESSURIZATION AND COOLING . . . **A** *Nose cone cooling,* **B** *Cabin pressurization and cooling,* **C** *Suit pressurization and cooling,* **D** *System control,* **E** *Heat exchangers,* **F** *Electronic bay (cooling and inerting),* **G** *Supply valve,* **H** *Nitrogen relief valve,* **I** *Liquid nitrogen storage tank,* **J** *Liquid nitrogen vent valve,* **K** *Liquid nitrogen filler valve,* **L** *Helium vent and buildup valve,* **M** *2-stage helium regulator, 4400-65 psi,* **N** *High pressure helium storage,* **O** *High pressure helium filler valve,* **P** *Helium relief valve.*

• ***The AiResearch Pressurization And Air Conditioning System*** in North American's X-15 is a radical departure from normal pressurization and cooling techniques, also pioneered by AiResearch, which up to now have utilized outside air surrounding the aircraft. When the X-15 manned spacecraft climbs into space beyond the earth's atmosphere, it will carry its own atmosphere in the form of liquid nitrogen dispensed through a self-sufficient AiResearch pressurization and air conditioning system for the pilot and vital equipment.

X-15 applications include: pressurizing and ventilating the cockpit and the pilot's flight suit inside of which he breathes pure oxygen; cooling and pressurizing electronic equipment and inerting its environmental atmosphere; cooling the plane's nose cone; and, operating pneumatic equipment.

High pressure helium gas is metered to a flexible expulsion bladder forcing nitrogen out of the storage tank, insuring a normal flow at all times.

From the B-29 to the modern jet airliner and now the X-15, AiResearch pressurization and cooling of these history-making aircraft exemplify the company's continued world leadership in the pioneering and advanced development of pressurization and refrigeration systems for high altitude, high speed flight. Your inquiries are invited.

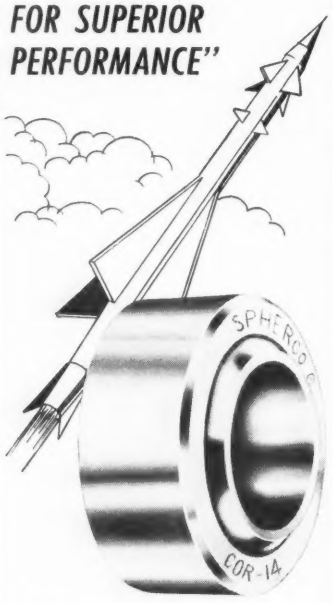
THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

SPHERCO®
SPHERICAL
BEARINGS & ROD ENDS
"PRECISION BUILT
FOR SUPERIOR
PERFORMANCE"



FEATURING...
- Quality engineered and produced
- Solid inserts
- Swage staking of 3-piece rod end
- Wide range of metals for races

WRITE FOR BULLETIN 257

SPHERCO
A PRODUCT OF
SEALMASTER BEARING DIVISION
STEPHENS-ADAMSON MFG. CO.
54 RIDGEWAY AVE. • AURORA, ILL.

Duzce, near Istanbul, Turkey. Latter could presumably track Discoverer, Sentry, and other polar orbit satellites on their first pass across Russia.

• AF is requesting funds for construction of the first MIDAS (Missile Defense Alarm System) interrogation station in the northern part of the United Kingdom. The facility is tentatively planned for Scotland, to operate in conjunction with the BMEWS (Ballistic Missile Early Warning System) radar planned for the area. The MIDAS station would utilize the high-speed BMEWS communication system for transmission of any attack warning secured by means of IR detection gear in the MIDAS satellites.

• U.S. is studying an Israel Astronautical Society proposal for a satellite tracking station to be built with U.S. funds and manned by Israeli technicians. There apparently is now only one such station in the Middle East—in Iran.

R&D

• The Sodium Reactor Experiment conducted by North American's Atomics International Div. for AEC has generated superheated steam of 1000 F, the highest steam temperature yet produced by a reactor.

• NSF has thus far made grants totaling $1,686,225 in support of projects for the International Geophysical Cooperation Program.

• AF awarded Cutler-Hammer's Airborne Instruments Laboratory a $38.9 million contract for design and development of airborne electronic equipment, in cooperation with Raytheon, Aerojet, Sperry, Sylvania Electric, Tempco, Filtron, and Haller, Raymond and Brown.

• Navy, using plans developed by NRL, will build a radio telescope at Sugar Grove, W.Va., with a theoretical range 19 times that of the Palomar optical telescope. The telescope will have a saucer-shaped antenna 600 ft in diam, and should dwarf any instrument yet built to probe the universe.

• Arthur D. Little, Inc., has come up with an 8-oz device for supercooling infrared detectors to −350 F.

MATERIALS

• Methods for depositing chromium coatings on molybdenum and for welding and brazing molybdenum are described in two reports issued by OTS, Dept. of Commerce. MIT did the work on coatings, with Battelle Memorial Institute handling welding and brazing techniques, as well as an investigation of the most practical joints and cleaning and test methods.

• Carbon derivatives of boron hydride, under development by Thiokol's Reaction Motors Div. as constituents of solid propellants, now give almost the energy increase (10 per cent above current solids) needed to warrant a production program. RM is also attempting to adapt modified hydrazine to its line of packaged liquid-propellant motors to achieve a system that will compete with coming solids in density specific impulse.

• Lockheed's Georgia Div. will build and test two large rocket cases made of a new U.S. Steel high-strength-to-weight ratio packrolled steel sheeting. The AF program will include a study of handling techniques for sheets up to 10 by $12\frac{1}{2}$ ft in size.

INDUSTRY

• Navy canceled Metal Hydrides $13.5 million sodium-borohydride contract, announcing that amounts of this chemical on hand are "surplus to the needs of the government."

• Celanese will develop and produce high-energy propellants and propulsion systems through controlling interest in the now wholly American-owned Amcel Propulsion, Inc., which is acquiring for this purpose the plant previously owned and operated by the Oerlikon Corp. of Switzerland at Asheville, N.C.

• Raytheon will tie together its widespread interests in countermeasures and infrared technology—engineering, production, and marketing—in an electronic warfare center, to be known as the Santa Barbara Subdivision, in Santa Barbara, Calif.

• National Research Corp. and Aerojet-General announced an exclusive licensing agreement under which Aerojet will use National Research's unique vacuum processes and equipment to produce solid-propellant ingredients.

JAPAN

• Japanese State Minister Y. Nakasone said that his country now has the technical competence to develop a multistage earth-satellite rocket, and that he hopes to turn this competence into a five-year project shortly.

ROCKET ENGINES

NEW tungsten linings for rocket nozzles . . .

MELTING POINT: 6170°F.

Tungsten-lined lightweight nozzles for solid propellant engines are now being fabricated by General Electric. With a lining melting point of 6170°F, these are among the highest temperature lightweight fixed and flexible nozzles in use in the missile industry, enduring high rocket propellant temperatures and pressures with no measurable erosion.

These nozzles are produced by an arc-spraying process pioneered by General Electric. Tungsten is vaporized in an arc and deposited on a mandrel. For some applications, the liner is molded in lightweight plastic, and the mandrel leached out.

Arc-sprayed nozzles have been hot-fired with the new high temperature propellants at several locations.

G.E.'s capabilities in metallurgy and manufacturing are combined with equally advanced capabilities in engineering, research and development. Integrated advanced rocket engine capabilities at General Electric can meet your needs for high performance solid propellant engine cases, nozzles and liquid engine components using cryogenic and storeable propellants.

Progress Is Our Most Important Product

GENERAL ELECTRIC

The Flight Propulsion Laboratory Department's Rocket Engine Section is the nucleus of General Electric progress in rocket engines and their components. It is well-equipped; and it uses Company-wide capabilities and experience to speed advances. If you would like more information about the section's products and capabilities in solid or liquid propulsion systems, please mail this coupon. Rocket Engine Section, General Electric Co., Cincinnati 15, Ohio.

Section R182-2
Rocket Engine Section
Flight Propulsion Laboratory Department
General Electric Company
Cincinnati 15, Ohio

Please send me additional information about General Electric solid propellant cases and nozzles (GED-3763). ☐

I would like to discuss G-E rocket engine products with a sales representative. ☐

Name .....
Title .....
Company .....
Address .....
City ..... **State** .....

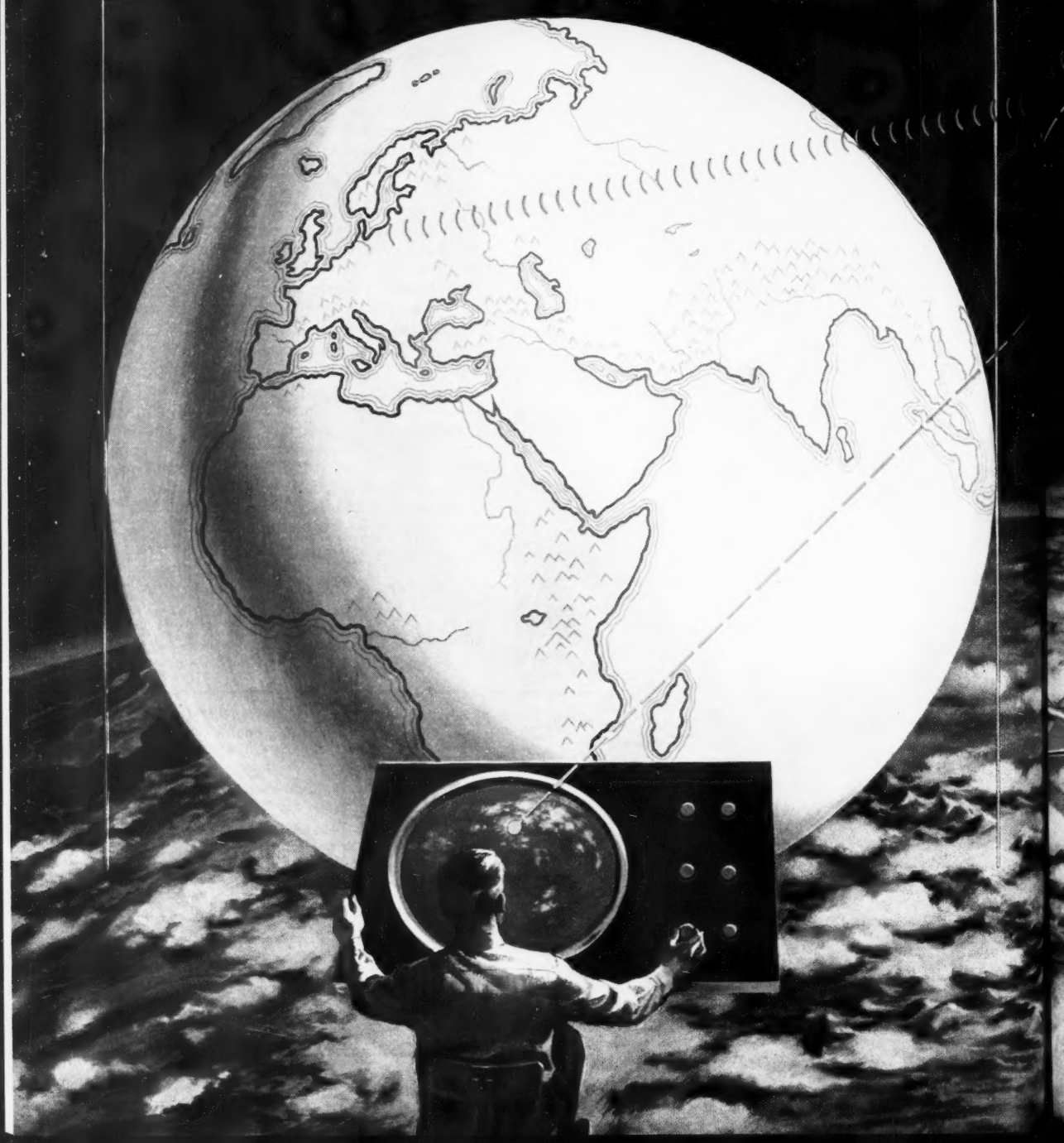
DEPARTMENT OF TECHNOLOG
BUFFALO & ERIE COUNTY PUBLIC LIBR

Marquardt

ADVANCED SIMULATOR-TRAINING SYSTEMS

FOR AIR AND SPACE

UNIQUE MARQUARDT CONCEPT SHRINKS EARTH TO 14-FEET



Advanced land mass simulation concept demonstrates Pomona Division capability in realistic simulators for lower-cost training of America's air and spacemen.

IN DEVELOPMENT:

A Marquardt-conceived land mass simulation system that shrinks the map scale factor to 1:3,000,000, while enabling the operator to distinguish landmarks smaller than a football field from any altitude! Application today: ground-training airmen for intercontinental missions at great savings in cost — using a single 8-foot map to realistically simulate the radar reflectivity and shadow effects of a 4,000-mile mission. Application tomorrow: training the free world's first space explorer for his safe return to earth.

IN PRODUCTION TODAY:

Pomona Division's AN/GPS-T4 Radar Signal Simulator, a relatively low-cost training system that is simple, compact, flexible and realistic; producing synthetic target and IFF video information for radar display. Current mission: training USAF aircraft controllers to direct interceptor missions. Ready adaptability will permit the T4 to simulate missiles, radar surface targets and sonar targets.

IN THE U.S. DEFENSE INVENTORY:

The USAF's AN/APQ-T1, AN/APG-T1A, AN/APQ-T2 and T2A, and AN/APQ-T3 simulator-training systems, plus the USN's 15WV-2 AEW/CIC trainer system — all developed and manufactured by the Pomona Division and its predecessor companies. Numerous sub-systems, up-dating modification kits, adapters, spares, and a worldwide field service section add to the organization's total experience.

POMONA DIVISION of The Marquardt Corporation is an able and experienced organization with demonstrated capability in advanced research, design, development and production. The result is reliable hardware which provides solutions to the problems of training military operational personnel.

Drawing on the Corporation's overall management-engineering skills, additional facilities and financial support, Pomona Division now offers industry and the Armed Forces a unique and proven ability to get the job done—delivering vital simulator-training system both on-time and at minimum cost.

OPERATIONS AT:
Van Nuys and
Pomona, California
Ogden, Utah
SUBSIDIARY:
Cooper Development
Corporation,
Monrovia, California

THE Marquardt
POMONA DIVISION CORPORATION
2709 No. Garey Avenue, Pomona, Calif.

Engineers and scientists capable of contributing to advances in state-of-the-art are invited to write to: Dr. Wendell B. Sell, Vice-President.

For the record

The month's news in review

June 1—DOD reveals that Lockheed has been named prime contractor for Project Midas, and awarded $10.8 million in secret contracts for the infrared missile-detecting devices.

—Space monkey Able dies.

June 2—Senate Space Committee approves $485.3 million for NASA in fiscal 1960.

June 3—AF Discoverer III, containing four mice, fails to orbit.

June 4—Herbert F. York, director of DOD research and engineering, confirms U.S. is working on anti-missile ray.

June 6—Army discloses that egg fertilization experiment in Able-Baker rocket showed cell life could continue in space.

—Message taped by Pres. Eisenhower is sent via the moon from Boston to Prince Albert, Can.

—Canadian Prime Minister Diefenbaker says joint Canadian-U.S. satellite will be launched in 1961.

—AF Atlas explodes 2 min after launching.

—Plaque honoring Robert H. Goddard is unveiled at Clark Univ.

June 7—Navy and NSF announce plans for cosmic ray study by plastic balloons.

—U.K. "flying saucer," Hovercraft, makes successful trial flight.

June 8—X-15, with Scott Crossfield as pilot, completes first freeflight test.

—First missile mail shipment is sent via Regulus launched from sub off Atlantic Coast to naval station at Jacksonville, Fla.

June 9—Soviet journal reports that Soviet Academy of Sciences has set up a special group of international law experts to study space-age legal problems.

June 10—Soviet astronomer Viktor A. Ambartsumyan becomes first Russian scientist to be made a foreign associate of NAS.

June 11—AF fires Thor-Able 5000 miles, but fails to recover nose cone.

—Britain fires Black Knight rocket more than 500 miles.

—Report of UN Committee on Peaceful Uses of Outer Space urges establishment of traffic control system to avoid satellite collisions.

June 12—Administration earmarks additional $157 million for Army Nike-Zeus program and reduces spending on obsolete weapons.

—Navy says it has been working on a long-range guided torpedo, Astor, for more than two years, with Westinghouse as contractor.

June 15—U.S.S.R. agrees to study for detection of nuclear tests in outer space.

—AEC-DOD report reveals that two hydrogen bomb tests in 1958 disrupted radio communications for thousands of miles.

June 19—AF successfully test-fires Bold Orion and escape space capsule.

June 22—Navy Vanguard fails to orbit.

June 24—Administration rejects proposal for early construction of atomic plane.

June 25—AF Discoverer IV fails to orbit.

June 27—Defense Secy. Neil H. McElroy says both U.S. and Russia are behind schedule in race to perfect combat-ready ICBM, sees Atlas operational target date postponed 60 days.

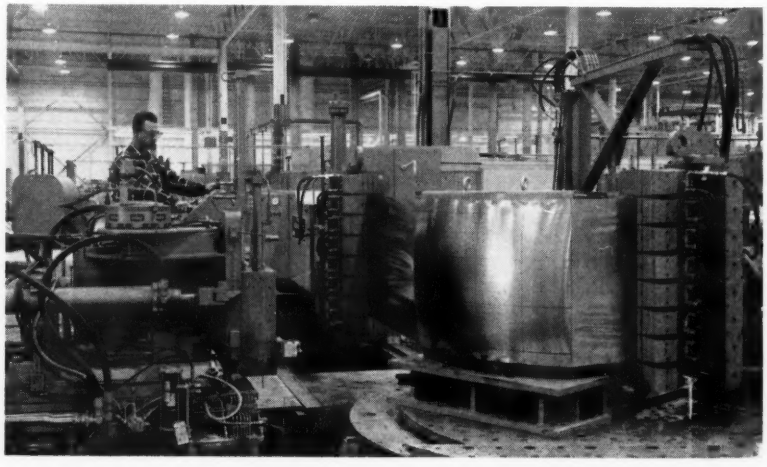
June 28—NASA spokesman says Army's Redstone has been chosen for training flights of Mercury astronauts.

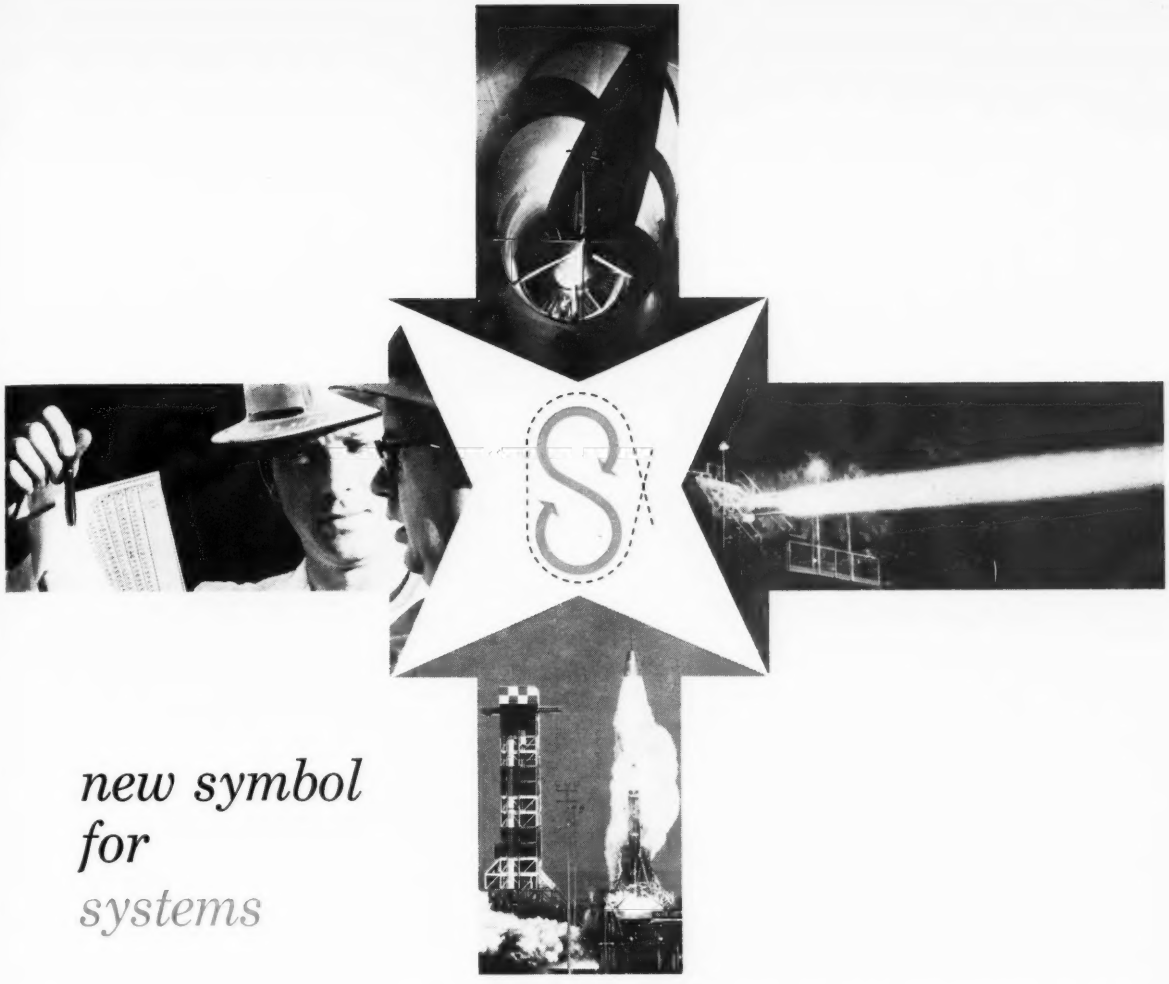
June 29—Navy successfully tests Polaris missile.

June 30—NSF announces work has begun on space telescope to be launched in a satellite.

Monroe Fit for Missile

Convair-Astronautics recently put into operation this 93-ton machine for stretching stainless steel into contoured skin for Atlas. It can stretch a 20-ft sheet near Atlas maximum skin thickness of 40 thousandths of an inch as much as 18 in.

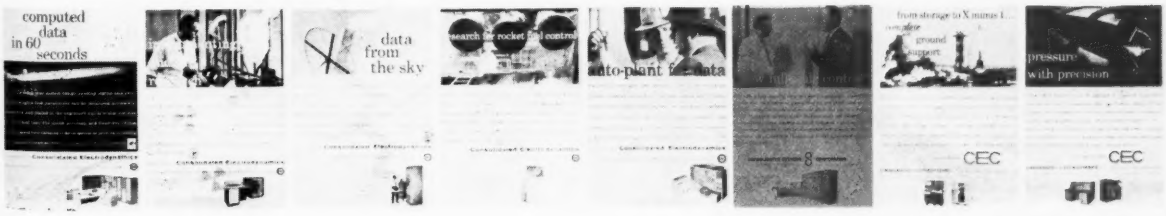




new symbol
for
systems

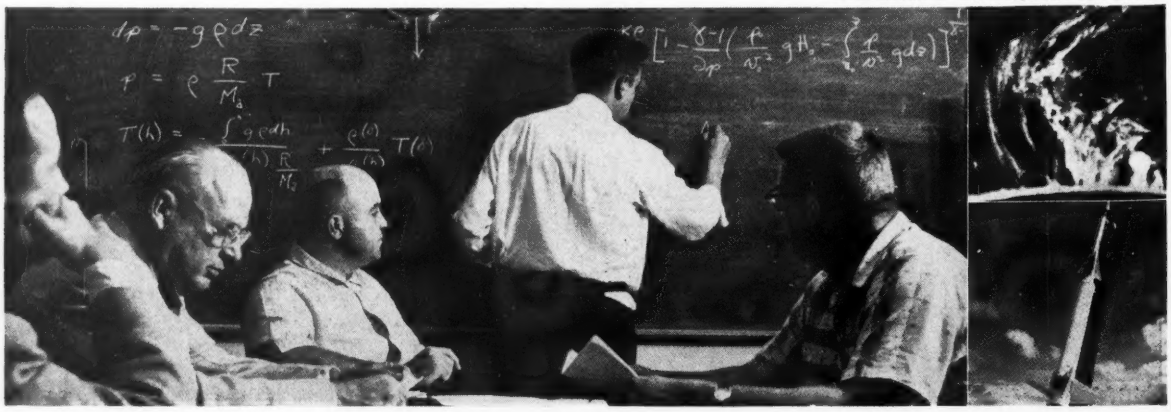
In five years of operation, Consolidated Systems has climbed from less than one-quarter million to over eight million dollars in custom-engineered systems for dynamic and static testing, chemical analysis, industrial control, and high-speed analog and digital data processing. This unprecedented growth in specialized systems (including missile ground support and cryogenics) is proof of quality – of performance – and of customer satisfaction. Over 500 systems have been designed, manufactured, and installed. These are *operating* systems producing data where time is critical and performance is paramount. Read about them in Bulletin CEC 1304-X54.

CONSOLIDATED SYSTEMS CORPORATION
1500 So. Shamrock Ave., Monrovia, California
A SUBSIDIARY OF
CONSOLIDATED ELECTRODYNAMICS



Southern California opportunity for creative rocket systems scientists, engineers. CDC's current expansion has created several key openings. Specialist in complete rocket systems, CDC offers you opportunity to join the team that has helped orbit America's satellites...to contribute to upper-atmosphere and space research programs like Explorer, Vanguard, Sunflare, Eclipse and Project Mercury. Rewards are high if you can generate original ideas and take responsibility on your own shoulders. A subsidiary of The Marquardt Corporation, CDC assures you outstanding career stability. **High-level Engineering Writer.** Capable of assuming responsibility for creative engineering writing on preliminary design concepts. **Aerodynamicist.** B.S. in A.E. Familiar with drag prediction in subsonic and supersonic flows. To perform drag and stability analyses on rocket motors. **Physicist.** Ph.D. or M.S. preferred. Experienced in research and analytical studies in upper atmosphere physics. Knowledge of meteorology helpful. **Instrumentation Engineer.** B.S. in M.E., E.E. or physics. Experienced in development of instruments and instrumentation systems. **Electronics Engineer.** Experienced in transistor theory, instrumentation, and telemetering systems. **Project Engineer.** B.S. in physics, M.E. or A.E. Familiar with sounding rockets, aerodynamic heating problems and stress. Experienced in organizing a project. **Senior Systems Analyst.** M.S. or Ph.D. To head group. Experience in propulsion, guidance, instrumentation, aerodynamics, thermodynamics preferred. **Senior Mechanical Engineer.** To head mechanical development group. Experience in rocket vehicles, mechanical auxiliaries, ground handling equipment, and rocket launchers desirable. **Systems Engineers.** B.S. or M.S. Broad systems knowledge. To work in field of design concepts. Live and work in Southern California, a healthful, year-around vacation land. Call or write Ben Hedding, Personnel Director, immediately. **Cooper Development Corporation,** 2626 South Peck Road, Monrovia, California, MUrray 1-5664

A SUBSIDIARY OF THE MARQUARDT CORPORATION



The mail bag

Meters Vs. Feet

For some years now I have been reading your ARS JOURNAL (formerly JET PROPULSION), in addition to reading seven other journals on rocketry and astronautics, and know from experience that the JOURNAL is the best one in the world.

Each year I translate some 30 ARS-J articles into German. However, I have found that some 10 per cent of the time taken up in this translation work is devoted to conversion of data and graphs from the nonmetric into the international metric system.

I know that most of the English-speaking people are used to inch, pound, Btu, etc., and don't like the metric system. However, it should be kept in mind that the ARS JOURNAL is not only of national, but also of worldwide, importance.

Would it therefore be possible to recommend the international system to authors? It would be a great help to many foreign readers.

ECKARDT W. SCHMIDT, Cand. Chem.
Daimlerstr. 11
Tuebingen, Germany

Martin Summerfield replies: "Having been trained originally as a physicist, I used to regard the metric system as the fundamental one, and didn't like the foot-pound-second system. Therefore, I fully understand your point of view.

"However, for the present and foreseeable future, I regard it as a hopeless task to get American and English engineers to change to the metric system. As an Editor, I cannot refuse papers using the FPS system; most of them are written that way. As a working scientist and teacher, I have learned to use both systems with equal facility. I am sure you do, too."

Wrong Rad, No Sourdough

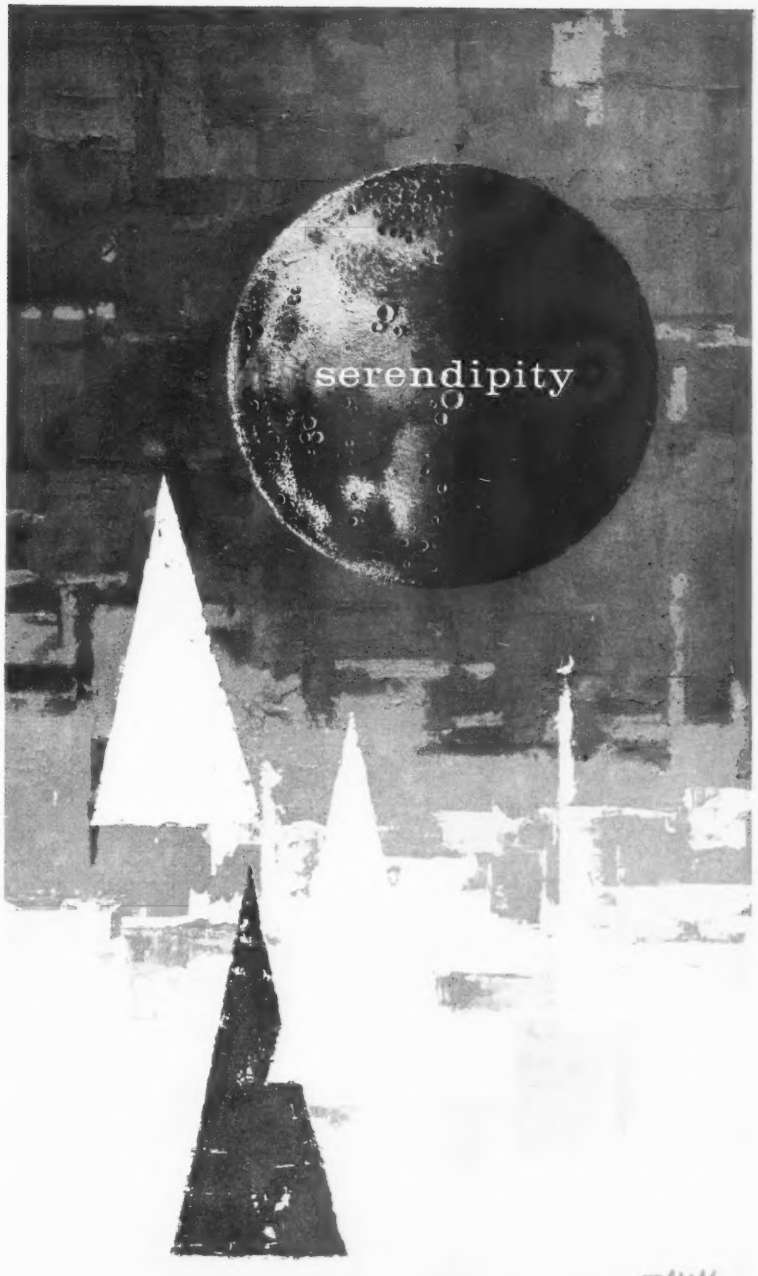
My paper "Radio Guidance of Vehicles into Space" (June ASTRONAUTICS) contains, not owing to you, an error in the last line of the table on page 21; it should read *10 microrad/sec* rather than 10 millirad/sec. By the way, how about letting my friends know I did *geophysical* prospecting, all in the interest of earth sciences, and sans beard and starting dough.

E. B. MULLEN
GE Defense Electronics Div.
Syracuse, N.Y.

Move on Movies

I read with interest the article "Miniature Movies of the Planets" by S. C. Baker and J. M. Kelso in the May issue. Perhaps some of your readers would be interested in a related system for obtaining televised pictures from a spinning rocket. The reference is "Single-Line-Scan Television" by F. H. Harris and J. Ainsworth, *Review of Scientific Instruments*, Vol. 30, No. 2, 76–78, February 1959.

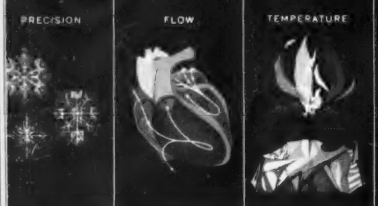
F. H. HARRIS
Naval Research Laboratory
Washington 25, D.C.



transcending present knowledge . . . *creating new concepts in space science . . . a unique challenge for persons who seek intellectual stimulation and association, and are able to recognize and use the serendipity which awaits scientific discovery. At MARTIN-DENVER, post-Titan space programs now in progress offer the professional mind an opportunity for great personal advancement. Inquire immediately of N. M. Pagan, Director of Technical and Scientific Staffing, The Martin Company, P. O. Box 179 (BB-4), Denver 1, Colorado*

MARTIN
DENVER DIVISION

NUMBER FOUR IN A SERIES... ENDURANCE



NEW DIMENSIONS IN

reliability

"to strive, to seek,
to find, and not to yield"
LORD TENNYSON

CADEL PRECISION PRODUCTS

reliability

A DIVISION OF GENERAL METALS CORPORATION
10777 VANOWEN ST., BURBANK, CALIFORNIA

DISTRICT OFFICES:
MINEOLA, L.I. NEW YORK • DAYTON, OHIO • WICHITA, KANSAS

COVER: *Snow-covered mountain peaks provide a cool backdrop for Titan battleship firing at one of the Martin-Denver test stands* (*see page* 26).

Astronautics

AUGUST 1959

The San Diego Meeting

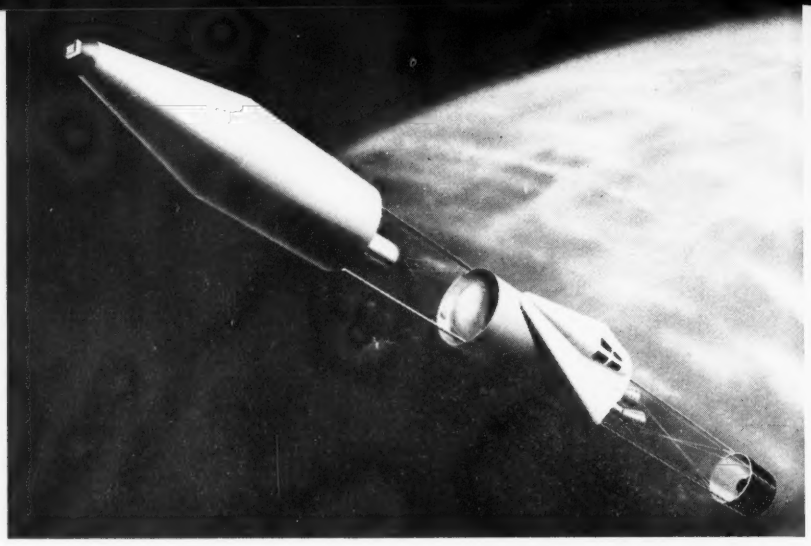
The stature and maturity of the AMERICAN ROCKET SOCIETY as a scientific organization was established beyond all question by the Semi-Annual Meeting in San Diego June 8–12. Professional smoothness in the management of the meeting, resulting from the outstanding work of John Naugle, General Chairman, and the local San Diego Section, permitted the fullest emphasis to be placed on the technical program and the Astronautical Exposition. The Program Committee, under the capable leadership of National Program Chairman Brooks Morris, demonstrated its effective operation through the selection and presentation of a large number of impressive technical sessions—the responsibility of the respective Technical Committee chairmen—combining quantity with high quality.

One of the high points of the five-day get-together was the dinner-meeting of the ARS Board with the Technical Committee chairmen. Here the booming, enthusiastic spirit of ARS was in full flower. The excellent work done by Past President George P. Sutton in organizing these committees was encouragingly reflected in the reports of the committee chairmen.

Because of the fine work done by the San Diego Section, ARS national officers were able to join with local officers in an informal dinner at the end of the meeting to celebrate the success without the usual post-meeting fatigue.

The meeting sets a new standard for national ARS meetings, presaging the continuous improvement that should be a part of the growth of the Society as it successfully meets the challenge of leadership in rocketry and astronautics.

John P. Stapp
President, AMERICAN ROCKET SOCIETY



Outpost II

Design for the future

Manned outposts in space

By 1963, national space capability will require biotechnical satellite stations like those described here as a transition between Project Mercury capsules and manned lunar and interplanetary spacecraft

By Krafft Ehricke

CONVAIR, A DIVISION OF GENERAL DYNAMICS, SAN DIEGO, CALIF.

Krafft Ehricke, an inspired advocate of spaceflight, is program director, Project Centaur-Vega, Convair-Astronautics. After graduating as an aeronautical engineer in Berlin, Germany, he worked at Peenemuende during WW II on the V-2 project. He signed a U.S. Army contract in 1945, working from 1947 to 1950 as a research engineer on ramjet and rocket systems at Ft. Bliss, Tex., and from 1950 to 1952 as head of the Gas Dynamics Section at Redstone. From 1952 to 1954 he was an engineer with Bell Aircraft Corp. He joined Convair in 1954.

DEVELOPMENT of our space capability, based on instrumented vehicles, must be implemented by manned space operations as quickly as possible. It is, of course, toward this end that the X-15 and Project Mercury developments are directed.

Today, intergrated long-range programing of major technical and scientific endeavors is more vital than ever before. It is therefore necessary to look ahead now to the next capability plateau in space technology—the permanent, inhabitable space station.

This "Outpost" type of station differs in many respects from its immediate predecessors, the Mercury capsule and a possible two-seated successor. Since the Outpost station will be "permanent," it can be inhabited intermittently for varying periods of time. Supply requirements and intermittent habitation will involve earth-to-orbit (ETO) logistics and the development of a well-functioning ETO supply system—needed, anyway, not much later, for certain lunar and interplanetary operations. Moreover, since it will be quite a bit larger than the Mercury system, it will be able to simulate more realistically the size of the crew compartment of manned lunar and interplanetary vehicles.

Analysis of the probable development of our manned space capability over the next few years indicates the need for an experimental biotechnical space station of the Outpost type not later than 1963.

Operationally, the Outpost station represents a transition from flight in orbital capsules to manned deep-space missions.

Many uses suggest themselves for Outpost stations. They could:

1. Permit selection and training of crews for long-term, deep-space missions under proper environmental conditions.

2. Serve as a test bed for the development and long-term flight-testing of components and equipment for future manned and unmanned spacecraft.

3. Aid in development of techniques for ETO operations, including rendezvous with the station in unmanned cargo ship operations, crew rotation, etc. Capability in this area is a must for many deep-space missions.

4. Serve to condition spacecrews in life-support systems for extended missions. One example might be to train a crew to live on a lunar-g level in preparation for a lunar landing or assignment to a lunar base.

5. Serve as a global meteorological and communication station, and as an astrophysical research laboratory.

6. Prove useful in the conducting of laboratory experiments, especially of a biological nature, under zero-g conditions.

Naturally, no single station could be expected to support all these activities simultaneously. However, they could either be staggered timewise or, if time is of the essence, carried out simultaneously in a cluster of Outpost stations.

The importance of the manned Outpost station from the standpoint of deep-space operations cannot be overestimated. It will, for example, prove of tremendous value in the selection and training of spacecrews, since it will permit, for the first time, detailed study of the effects of prolonged exposure to zero-g conditions and of psychological effects of long periods of separation from earth and suspension in the supreme loneliness of infinite space.

It will also permit the development of reliable life-support systems which have been tested under proper environmental conditions. Life in space will require a complete revaluation of everything which is now part of a person's life. Every piece of equipment, every fixture, every stick of furniture—individually and in consonance with man's entire environmental system—must be checked out and proved usable, reliable, and durable under prolonged exposure to space conditions before human lives can safely be entrusted to it.

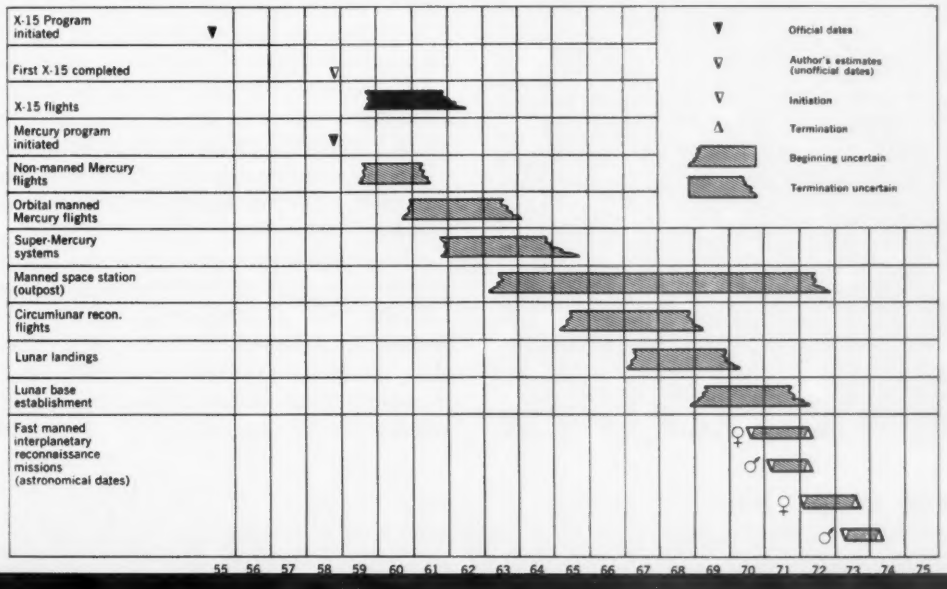
Important for Future Missions

Not until problems of this nature have been satisfactorily solved will we be able to launch manned spacecraft directly from the earth to the moon with full confidence. The Outpost station is therefore especially important for developments which aim to avoid costly and difficult assembly of interorbital space vehicles.

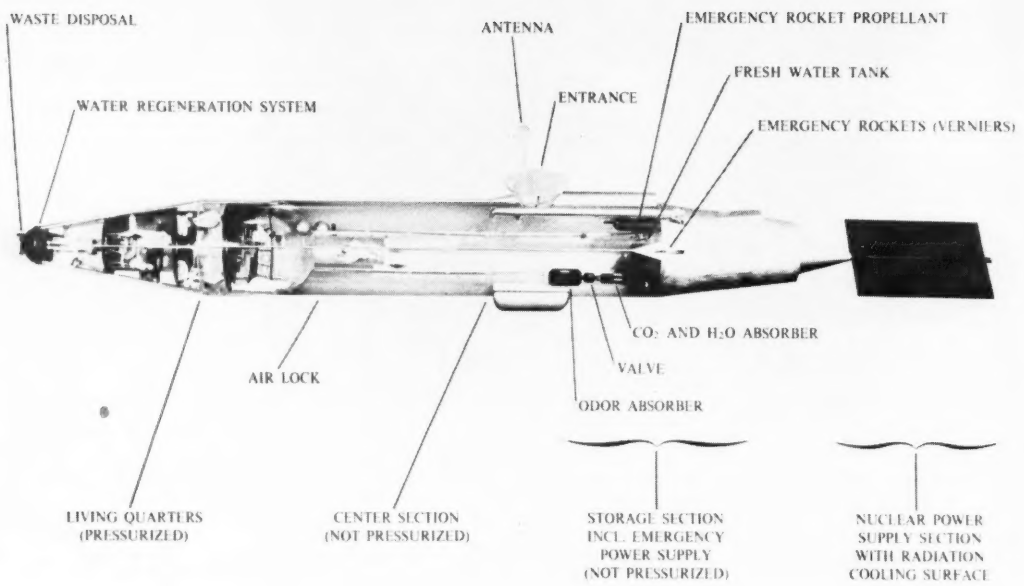
Granted the need for Outpost stations, and in a relatively short time, how might they be designed? The Atlas system, we believe, provides a basis for some practical thinking. Three concepts have been studied so far—designated Outpost I, II, and III—along the lines of proved Atlas hardware.

The Outpost I concept, shown on page 22, utilizes the capability of the Atlas vehicle to boost its large tank into orbit. This predicted capability was

The Outpost Station in a Schedule for Manned Spaceflight



Outpost I



Characteristic Data of 4-Person Satellite Outpost I

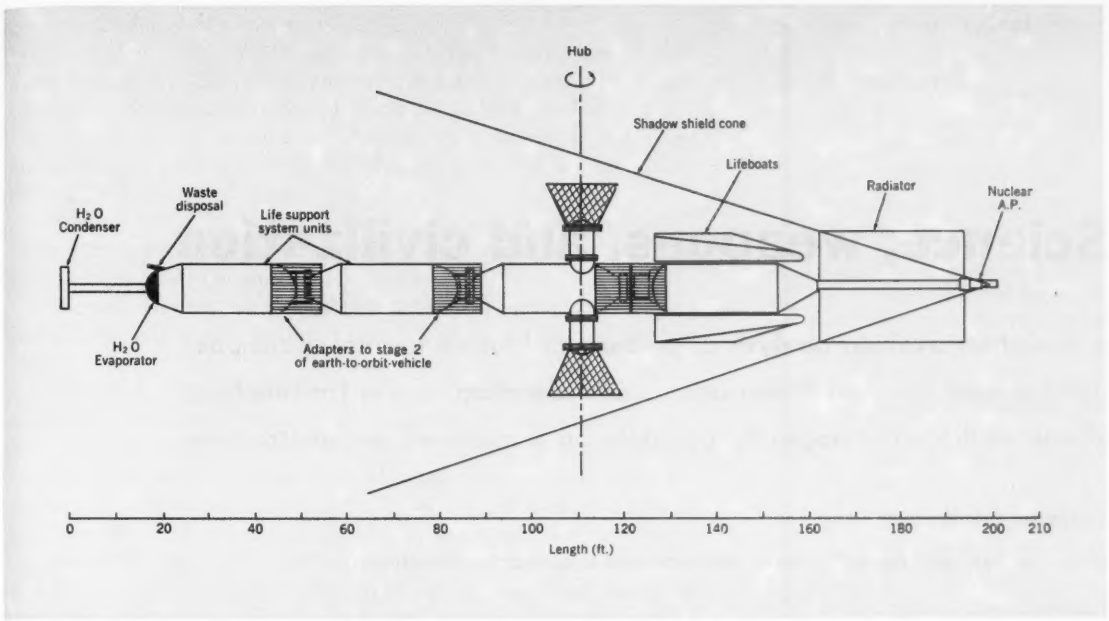
Over-all weight, equipped (without lifeboat vehicles attached)	≥15,000 lb
Return gliders (2 @ 2 persons) (lifeboat systems)	8300 lb
Over-all length of station (water regenerator to nuclear reactor)	106 ft
Length of life-support system (without air lock)	32 ft
Length of air lock	7.5 ft
Maximum diameter of life-support system	9.5 ft
Minimum diameter of life-support system (floor of sanitary room)	3.5 ft
Volume of life-support system (without air lock)	610 ft^3
Distance of center of mass from water regeneration system	≥55 ft
Angular velocity of station	3 rev/min
Circumferential velocity	
water regeneration system	17.2 ft/sec
cockpit of lifeboat systems	~5 ft/sec
Gravity level (g):	
Water regeneration system (55 ft)	0.166
Floor sanitary room (52.5 ft)	0.158
Floor galley (46.5 ft)	0.141
Floor sleeping room (40.5 ft)	0.126
Floor control room & lab (35.5 ft)	0.111
Coriolis acceleration (g) (at 3 ft/sec radial motion)	0.058
Water cycle	closed
Oxygen cycle	open
Waste cycle	open

proved experimentally with the launching of Atlas-Score (Model 10B) last December. In its final version, the Atlas will be able to launch the tank into a 350 n.mi. orbit. This is about the maximum permissible altitude in the vicinity of the earth, because of the need to avoid the Van Allen radiation belt. Once the tank is in orbit, cargo and crew members will follow, to modify the tank and render it inhabitable.

The Outpost I life-support system consists of four rooms. Its front end is closed by waste-disposal and water-regeneration systems; its rear end by an air lock. The rest of the tank is not pressurized, minimizing the effect of possible meteor damage and permitting rapid access to and egress from the interior of the station. An air lock at the tank entrance would require a considerably wider shadow shield cone (i. e., heavier shielding) for the reactor. The station can be rotated about an axis normal to its longitudinal axis to provide some artificial gravity for the crew. The use of water in the galley and in the sanitary room was a determining factor in placing these two rooms at the forward end, in the region of maximum gravity. Principal characteristics of the Outpost I space station are summarized at left.

The establishment of Outpost I involves considerable work in orbit until the station is ready for inhabitation. An alternate approach is to carry the front end, containing the life-support system (February 1959, ASTRONAUTICS, page 92), into orbit in one piece, more or less fully equipped, thus keeping most of the work of equipping and checking out

Outpost III



the space station on the ground. The advantages of this alternate approach are obvious.

Outpost II, illustrated on page 20, also takes this approach. The nuclear auxiliary power source is housed in the engine compartment of the second stage. Once in orbit, the life-support system, second stage, and nuclear auxiliary power system are pushed apart by means of telescoping beams to produce an over-all system length comparable to that of the Atlas tank, so that the gravitational conditions are similar to those of Outpost I.

Units Are Connected in Orbit

Outpost III, illustrated above, is a combination of four Outpost II units, each carried up fully equipped and checked out. The units are connected in orbit. The auxiliary powerplant, air locks, and other accessories are carried up separately and attached in orbit. Outpost III can accommodate up to 10 persons, and can be used for more comprehensive orbital research and development programs, as well as flight training for interplanetary spacecraft crews. For fast manned expeditions to Venus and Mars, requiring an over-all mission period of 1 to 1.6 years, with short satellitory capture periods near the target planet, a crew of between 4 to 8 persons per vehicle for three vehicles appears adequate. (See "A Systems Analysis of Fast Manned Flights to Venus and Mars, Parts I and II," Convair Report AZM-072, March and April 1959). (CONTINUED ON PAGE 42)

Characteristic Data of 8-Person Satellite Outpost III

Over-all weight, equipped (without lifeboat vehicles attached)	$\geq$50,000 lb
Return gliders (4 @ 3 persons) (lifeboat systems)	28,000 lb
Over-all length of station (condenser to reactor)	~210 ft
Number of individual units	4
Number of life-support system units	2
Minimum crew size	4 persons
Maximum crew size	10 persons
Volume of life-support system (2 units)	3000 ft^3
Distance of far end of life-support system from center of mass	~90 ft
G-load at this level (@ 3 rpm)	0.275 g
Distance of near end of life-support system from center of mass	~65 ft
G-load at this level (@ 3 rpm)	~0.2 g
Water cycle	closed
Oxygen cycle	closed
Food-waste cycle	Experimentally closed

Science, weapons, and civilization

A thought-provoking analysis of present and future technological possibilities and impossibilities, and a consideration of the far-reaching effects of the technologically possibile on tomorrow's social structure

By Howard A. Wilcox

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING, WASHINGTON, D.C.

Howard A. Wilcox was recently appointed deputy director of research and engineering for the Department of Defense. Formerly assistant technical director for research and chief of the Research Dept. at the Naval Ordnance Test Station, China Lake, Calif., Dr. Wilcox's background includes eight years of service with the Navy's Michelson Lab at NOTS, during which he served as Sidewinder project engineer head of the Weapons Development Dept. He has also taught and done research in high-energy nuclear physics at the Univ. of California.

The material contained in this article was originally presented in a talk given by Dr. Wilcox, then with NOTS, before the Indian Wells Valley Unitarian Fellowship early this year. The views expressed therein are those of Dr. Wilcox, and do not necessarily reflect the opinions of NOTS, the Navy, the Department of Defense, or the AMERICAN ROCKET SOCIETY.

THE TITLE of this article introduces a subject more important today than ever before, and tomorrow more than today. Perhaps the most important aspect right now of the impact of science on future civilization has to do with the science of military weapons. But, to say something meaningful about probable future development and use of weapons, one is compelled to ask questions about the probable and desirable kinds of future struggles among nations. And this, in turn, raises basic questions concerning the probable and desirable future patterns of activity of mankind in general.

We can ask these questions in various forms: What *will* happen? What *can* happen? What *should* happen? If some development is seen by everyone to be undesirable, it will presumably not occur. Likewise, if some development is judged by all to be impossible, it will not occur, whether in fact it is impossible or not. And, of course, modern science teaches what is all too seldom realized—that certain imaginable developments can be validly judged, now, to be in fact impossible of achievement.

We all can see that modern technology is connected with present-day social ferment. It is the important new factor. Dare I say it is an "unpredictable" factor? To most of us it seems so.

Technology Triggers Social Changes

The fact is that technology releases or triggers social change because it opens up new ways for people to satisfy age-old human desires. As human control over our environment increases, human desires and urges and schemes find new modes of expression. Our social customs and ethical systems have been evolved to protect us to some extent from certain human activities and their destructive effects. But ancient customs are perhaps inadequately, or even inversely, effective in protecting us from some of the new possibilities for human action and their unforeseen and undesirable consequences. It is an open question, then, whether new ethical principles can be created at sufficient speed, and with sufficient effective-

ness, to give us the desired social protection. This is perhaps the greatest challenge of our time.

Let us now ask: What are some of the present and future technological possibilities through which basic human motivations can find expression? In answer, I would list at least the following:

1. We now have the means—the radioactive means—to kill every living thing on earth at a level of biological organization higher than that of the insects and plants.

2. We can breed the human family fast enough to refill the earth's surface once every 30 to 100 years. In most areas, we are in fact breeding this fast, percentage-wise, now.

3. We will soon be able to send men to the ends of the solar system, and also to within some millions of miles of the surface of the sun itself.

4. Man has, and can soon have in more readily controllable and usable form, essentially unlimited energy—energy from the sun, and from the fission and fusion of atomic nuclei here on earth, for example. This, in turn, means that man can, in principle, solve his problem of material resources, for with essentially unlimited energy man can afford to process all manner of low-grade ores, and mine the ocean bottom, and even the sea itself, to obtain now-scarce minerals. Likewise, fresh water can be had in essentially unlimited quantities, provided only that sufficient energy is available with which to boil (or freeze) sea water.

5. With energy more available, we shall find it possible to move men and freight to all earthly places (and some unearthly places) at unprecedented speeds and quantities. In just a few years, vast numbers of travelers can be leaving Los Angeles, say, to spend weekends in Paris or Moscow. This activity could greatly help Americans in the U.S. to overcome a lamentable ignorance of the other languages of our world.

6. With energy more available, we can dig harbors and level mountain ranges, if we so desire.

7. With energy more available, there can be plenty to eat for all the people that can be accommodated on the earth's surface. In this respect, oceanic agriculture could be a most important factor.

8. By controlling the earth's reflectivity and emissivity during summer and winter, we can probably cause the polar icecaps to become larger or smaller, thus regulating the level of the oceans (within limits) to suit ourselves. It is entirely possible that potentially destructive storms can be dissipated before they become dangerous.

9. Artificial environments can probably be created for human habitation on the moon and Mars, assuming only that enough controllable energy is available.

10. It seems possible that a "translating telephone" can be developed, so that one could talk English into it and out of the receiver would come, say, Russian. This development might enable us to overcome the "language barrier."

11. It seems possible that improved techniques can be developed for teaching children, even to the point, perhaps, of keeping them enthusiastic for knowledge. Maybe we could train ourselves to exercise more independent and more careful thought and judgment.

12. Modern business and bookkeeping machines can be applied to monitor and control the daily activities of most of the human beings in a country, if desired or permitted by its citizens. I for one believe we should stoutly resist such a possible use of technology.

13. Electrodes permanently implanted (CONTINUED ON PAGE 81)

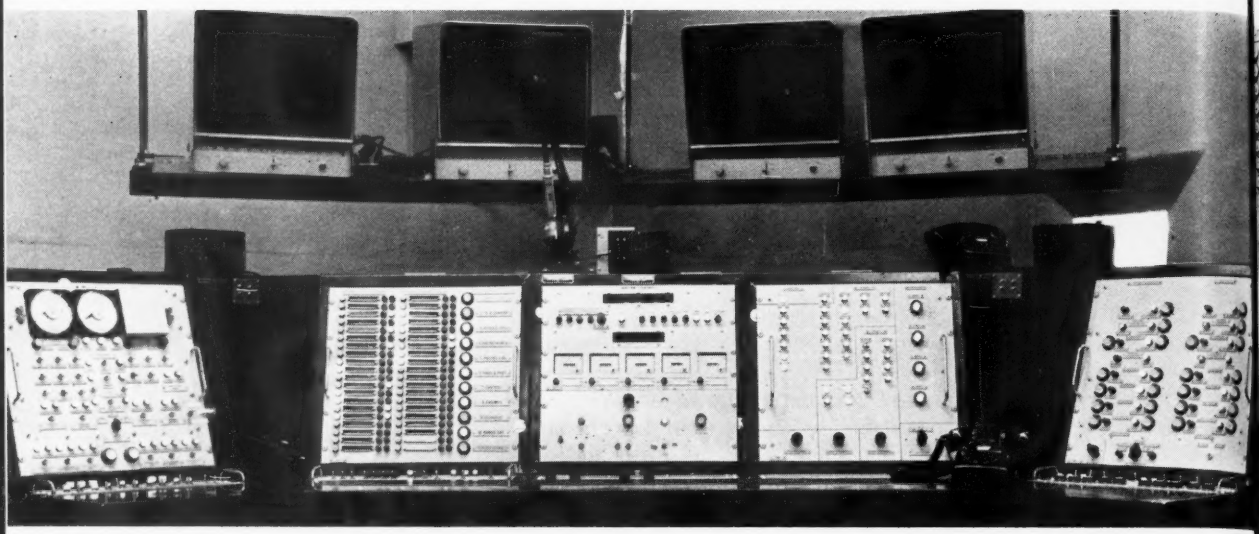
The Technological Future

Possibilities

1. *Use, in readily controllable form, of essentially unlimited energy.*
2. *Sending men to the ends of the solar system.*
3. *Moving men and freight in unprecedented quantities and at unprecedented speeds to any point on (or even off) the face of the earth.*
4. *Creation of artificial environments which will permit human habitation on the moon or Mars.*
5. *Breeding fast enough to repopulate the earth once every 30 to 100 years.*
6. *Control of man's own biological evolution.*
7. *Killing, radiologically, every living thing on earth above the biological level of plants and insects.*
8. *Prevention of death from biological causes.*

Impossibilities

1. *An "anti-gravity screen."*
2. *A "time-traveling" machine.*
3. *Creation of energy except by the vanishing of mass.*
4. *Use of any large fraction of the oceans' heat energy.*
5. *Compressing more than a definite maximum amount of information into a given "time-bandwidth product" for a given communication channel.*
6. *Measuring the "absolute speed" of earth relative to any postulated "absolute space."*
7. *Keeping any actual material body structurally solid if its average temperature rises above a few thousand degrees F.*
8. *Providing 100 per cent militarily effective defense of a large target such as the U.S. or the U.S.S.R.*



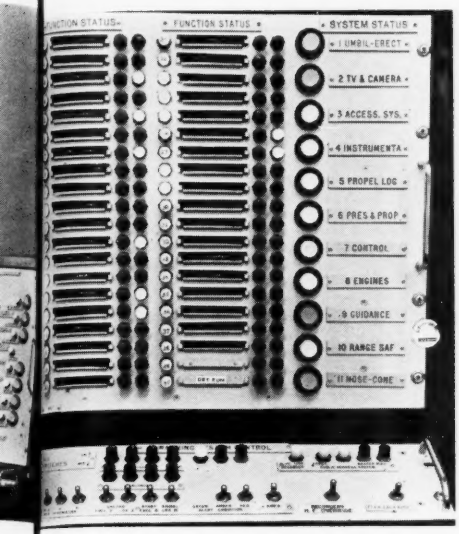
Testing a Titan

Thoroughness of testing in unique facilities at Martin-Denver contributed greatly to the success of the first Titan freeflights

TITAN, the third major project of the Air Force ballistic missile program established in 1955 (see "ICBM: Giant Step into Space," August 1957, ASTRONAUTICS), began freeflight testing early this year with four successive successful launchings under first-stage propulsion (the second stage being ballasted with water). Besides this exceptionally good early record, Titan showed a truly impressive stability in launching and ascent under power, with scarcely a ripple detectable in its trajectory.

The key to this success has been one of the most comprehensive test programs ever formulated for a machine. The flight test of a Titan represents the pinnacle of a broadbased pyramid of testing covering every component and every system, every material and every structure, every reproducible environment. The lessons of a preceding generation of mixed failure and success in missile development went into the planning of this testing program, as described by Simon Ramo in "Giant Step into Space." Emphasis on systematic testing in the Titan project in turn prompted the development of new testing equipment and procedures.

These pages show some of this equipment in the testing complex built and operated by the Martin Co., prime contractor for Titan, at its Denver

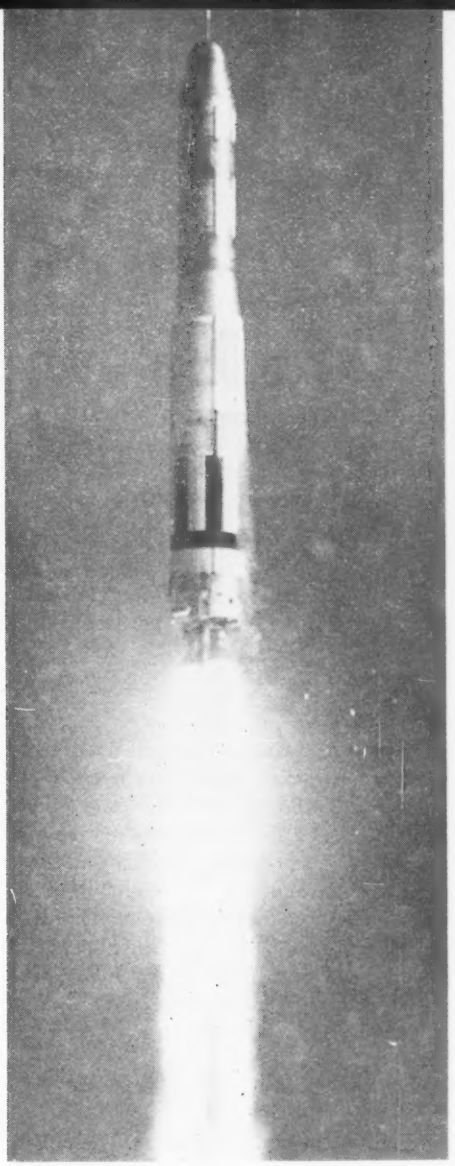


Left, the console of the Master Operations Control for both static and flight-testing of Titan, and, above, its Functions and Systems Status Panel. The center three panels make up the test-conductor's console. Besides allowing advanced programing, the MOC automatically monitors the countdown, acts as trouble-shooting system, and initiates a "hold-fire" at any sign of trouble.

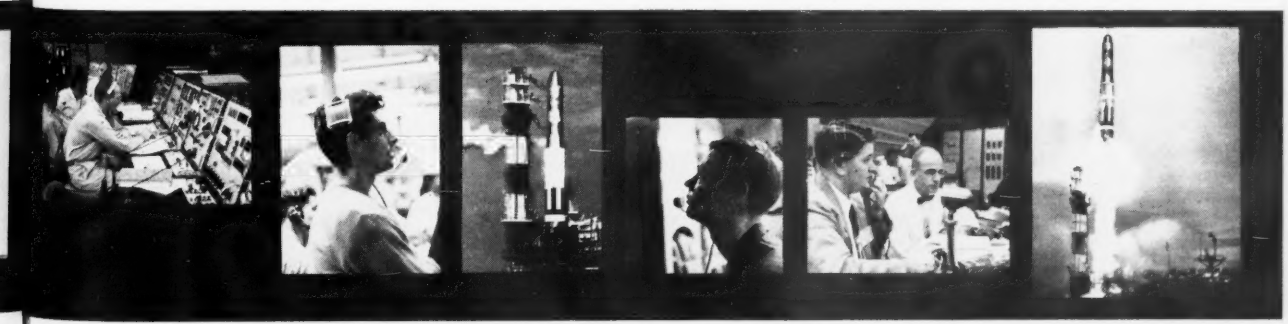
facility. The strip of photos below shows blockhouse operations at the Air Force Cape Canaveral launching area. The freeflight testing setup duplicates the static-testing system at Martin-Denver. Consequently, a Titan, air-lifted from Martin-Denver, arrives at Canaveral checked out and virtually ready to take off.

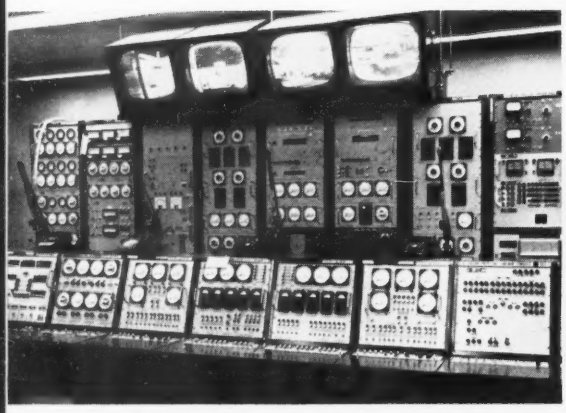
What are some of the features of the Titan testing complex and procedures used in checking out the missile before it is flown?

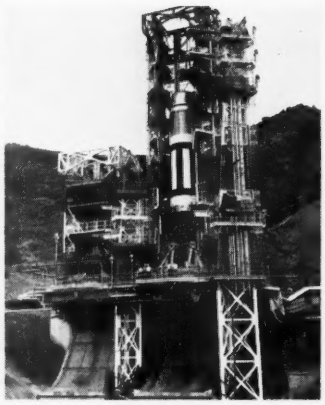
Most of the test program, and all of the final tests, are conducted at the Martin facility 25 miles southwest of Denver.



The page-spanning photo strip shows blockhouse activities during a countdown and launching of Titan; above, the missile in freeflight. The Master Operations Control appearing in this strip virtually duplicates the Martin-Denver static-testing equipment shown above. The thoroughness of final testing and checkout which the MOC allows at Martin-Denver, and the speed of missile-airlift to Cape Canaveral, make it possible to concentrate work at Canaveral chiefly on the missile launching proper.







Missile Compatibility Firing (MCF)—the last test at Martin-Denver before a Titan is delivered to Cape Canaveral for launching—takes place on a stand differing from the Canaveral launcher only in having fixed bolts to hold the missile down. Left, consoles and TV monitors for static testing; center, a Titan first stage on the stand awaits placement of the second stage in preparation for an MCF; and right, a complete Titan bolted down ready for testing in one of the four Martin-Denver static stands.

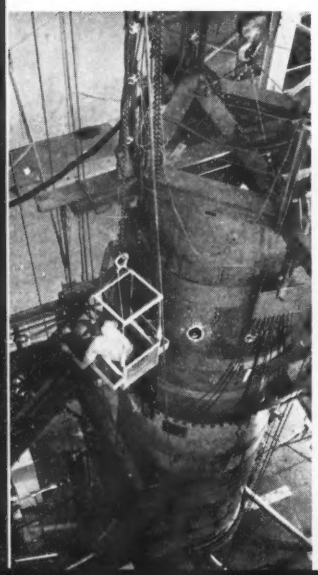
Laid out on a Ghant chart, the Titan test program appears a pyramid, at the base being thousands of individual component tests, the production environmental tests (PET), and comprehensive quality control testing; next, tests of assemblies, subsystems, and systems; then missile compatibility firings (MCF), when a Titan functions completely except for actual flight; and finally, topping the pyramid, the acid test, flight testing from the Air Force Missile Test Center at Cape Canaveral.

Production Environmental Testing

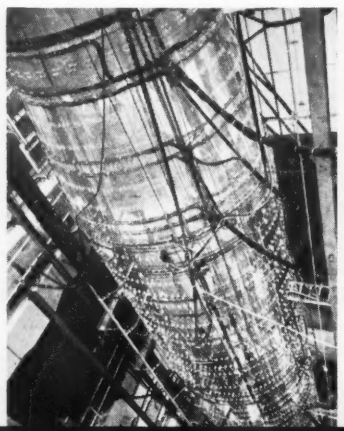
Roughly half of the individual component testing and production environmental testing (PET) is conducted at Martin-Denver. Of almost 500 major Titan components, over 185 are tested at the facilities of more than 4000 suppliers before going to the PET Laboratory at Denver. Rather than random testing, every item on a selected list undergoes PET. These tests are run so that the useful life of the component or subassembly is not reduced.

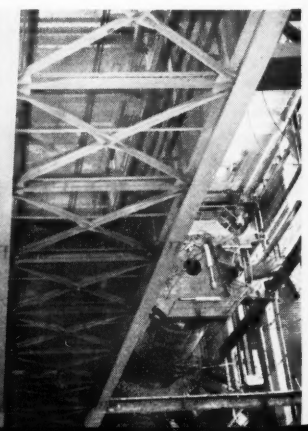
PET facilities include chambers for single and multiple environments (for instance, an item might be subjected simultaneously to pressure, heat, humidity, rain, and dust) along with shake tables, a centrifuge with an arm longer than 60 ft, and heat chambers.

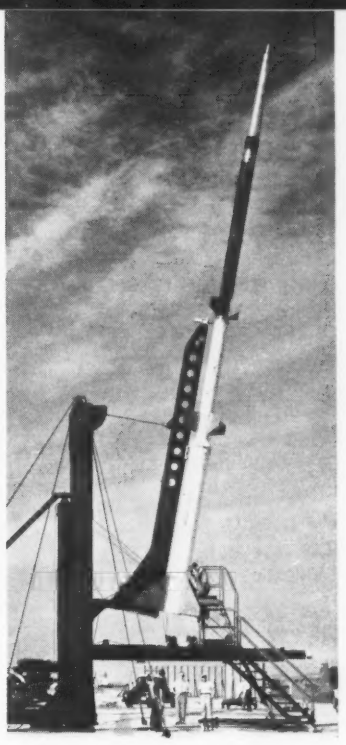
The cold-flow laboratory, now designated the propulsion lab, tests everything connected with propulsion but the rocket engine itself. Propellant tankage and plumbing is reproduced in this lab, and real or simulated pro- (CONTINUED ON PAGE 92)



The unique 13-story Vertical Test Fixture (VTF) at Martin-Denver contains seven Titan-sized cells for conducting development tests. Photos here give views into (left) closed cell where a technician is hooking up hundreds of strain gauges for a dynamic pressure test; (center) closed cell where a giant sleeve of quartz lamps will simulate aerodynamic heating under dynamic loads; and (right) the two open cells with missiles in preparation for testing. In the last photo, an elevator separates the two cells.







The six-stage re-entry study rocket poised for launching at NASA's Space Flight Station on Wallops Island, Va.

NASA-ARPA re-entry detection research

An economical six-stage rocket conceived by NASA is making possible new studies of re-entry phenomena and detection

NASA studies have shown that an anti-missile for point defense against ballistic missiles can be designed to be practical in terms of both size and cost, and that the aerodynamic design and controls for such a missile depend strongly on the time allowed for interception. Early detection of the incoming missile—hence more time for maneuver in the interception pattern—thus becomes a critical point of design.

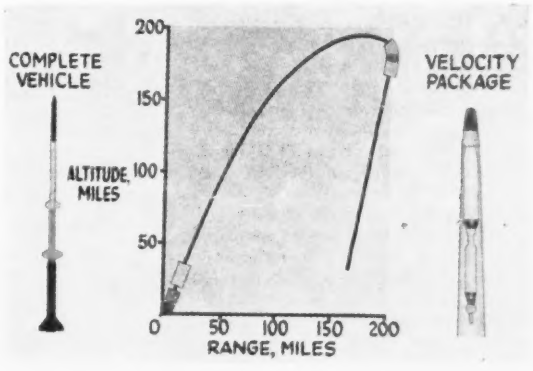
These concerns have led NASA and ARPA to join in a program to study re-entry phenomena and detection with optics, radar, and telemetry. This program employs an unusual six-stage rocket engineered by NASA.

Shown in the photo and depicted in the illustration, the six-stager consists of Honest John, Nike, and Lance boosters that propel a three-stage arrangement to an altitude of about 200 miles, as indicated in the trajectory graph. Separated from the lower three boosters, this arrangement—Thiokol T-40 and T-55 solid motors and a special NASA-developed motor all in a single overcasing, as shown in the sketch—rides the hump of the trajectory with constant attitude (nose up) and, as it begins descent, the three motors fire in sequence giving the terminal NASA rocket a velocity of roughly 16,000 mph, or nearly satellite re-entry velocity. The NASA motor is chiefly a 5-in.-diam sphere, which after this propulsion sequence gives the familiar meteoric trail on re-entry.

This rocket is launched from NASA's Space Flight Station on Wallops Island, Va. It is tracked optically from Wallops, Coquina Beach, N.C., and a NASA aircraft in the re-entry area, some 50 miles from the launching area. (The trajectory sketch is an early one showing greater separation of the two areas.) It is tracked by radar from Wallops also, but chiefly from the Millstone Hill installation of Lincoln Laboratory; and it is followed by Doppler telemetry from Wallops, Langley Field, Cape Hatteras, and Edenton, N.C.

This project reflects the dividends national programs are drawing from the multistage rocket studies started years ago by the NACA and continued by NASA. The six-stage rocket is relatively cheap and easy to handle, and the launching procedure for it much more simple and convenient than for a large rocket with guidance. Besides contributing to anti-missile studies, represented here by ARPA's Defender Program, this project should supply a wealth of valuable data for the Mercury program.

Re-Entry Detection Vehicle



Auxiliary power for space probes

Power rather than energy systems appear the key to auxiliary units for space probes, with the thermionic plasma diode very likely the system of the future

By Robert C. Hamilton

JET PROPULSION LABORATORY, PASADENA, CALIF.

A KEY concept in space power is the clear definition and classification of energy and power systems. Webster's New Collegiate Dictionary defines energy as "capacity for performing work" (whr) and power as "the rate of transfer of energy" (watts). To the engineer, energy is defined in terms of ft-lb, Btu's, or kwhr; power in ft-lb/min, Btu/hr, or kw.

Many different power sources, converters, and voltage and frequency regulators in various combinations can be used for interplanetary space probe power systems. A morphological chart of these power system components is given on the opposite page. One or more components in each of the three vertical columns may be combined with one or more components in each of the other two vertical columns of the chart. Some of the more attractive power systems are the following:

1. Solar power, photovoltaic solar-cell conversion, and transistor semiconductor static inverter control.

2. Radioisotope nuclear power, thermoelectric-semiconductor conversion, and transistor-semiconductor static inverter control.

3. Solar power, thermoelectric plasma-diode conversion, and transistor-semiconductor static inverter control.

A typical interplanetary space probe mission, for instance to Mars, requires an average power of 100 watts for 150 days, or a total of 360,000 whr of power. The comparative weights of several Mars interplanetary space probe power sources are as follows:

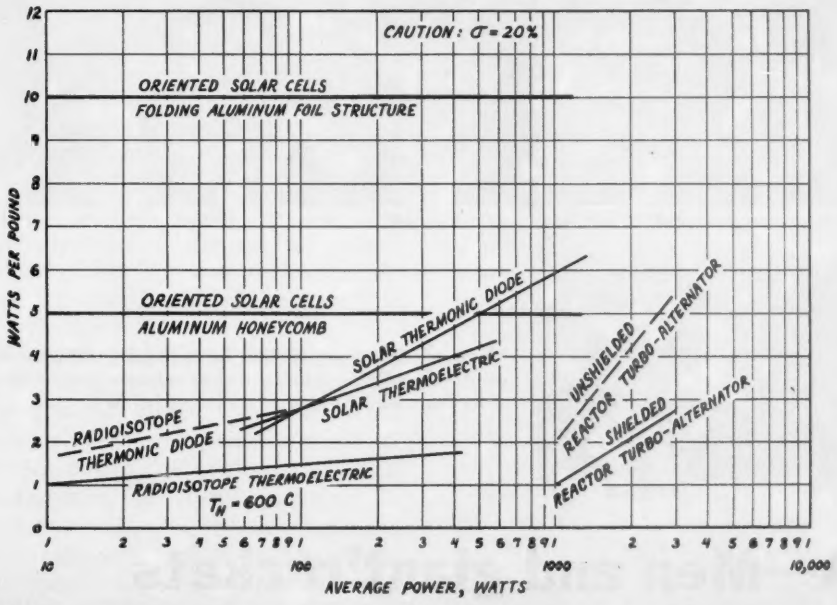
Energy Storage	
Batteries (80 whr/lb)	4500 lb
Fuel cells (250 whr/lb)	1420 lb
Power Conversion	
Oriented solar-collector thermionic diode (collector weight, 0.2 lb/ft² for 2.5 watts per diode)	47 lb
Radioisotope thermionic-diode converter (2.85 watts/lb for 2.5 watts per diode)	35 lb
Oriented solar-cell panel at Mars (5 watts/lb)	20 lb

These weights reflect various degrees of optimism and stages of development. They are comparative only grossly. The additional elements of an electric power system—the static inverter, cables, switches, and fuses—are not included, but would be equal for all systems. Vacuum-diode area is 4 cm².

Also, in a technical sense, a radioisotope power source is an energy (whr) system. However, the active radioisotope material is a small

Robert C. Hamilton is engineering group supervisor for space power systems at JPL. After receiving B.S. and M.A. degrees in engineering from the Univ. of Michigan in 1941 and 1942, respectively, he became a research and development officer at Wright Field's powerplant laboratory. At the end of WW II, he joined GM's Aeroproducts Div., serving for seven years as process and development engineer on electronic controls for turboprop engines, and then became a member of JPL's staff, engaging in analysis and development of missile and space-vehicle power systems.

Power Source Weight and Output for 150-Day Mars Trip



percentage of power system weight. Since most of the weight of the radioisotope thermoelectric converter is devoted to power conversion, this power system should logically and practically be classified as a power system.

The outstanding fact is that the energy systems are 30 to 180 times heavier than the power systems. We are left with this conclusion: Only the power systems—solar and nuclear—should be considered for interplanetary space probes.

How do power systems compare in terms of power level, cost, time of operation, and reliability? Before attempting answers to this question, it should be plainly put that most data on advanced power systems are tentative, not confirmed by design and test experience, and subject to standard deviation of the order of 50 per cent. It is stuff to think on, and to evaluate with engineering studies as soon as possible. Engineers will recognize this as no small challenge.

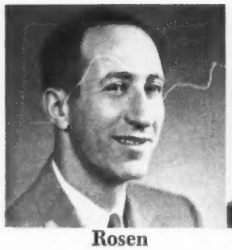
The graph above compares several promising systems in terms of weight and average power.

Solar Cells Play Important Role

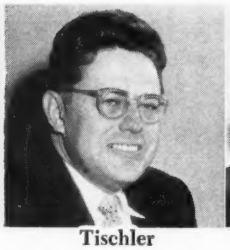
Oriented photovoltaic solar cells provide electrical power in space for the least weight and cost in the range from a few ten's to a few hundred's of watts. In the power range from 1 to 20 watts, radioisotope semiconductor thermoelectric converters are very competitive with both unoriented and oriented solar panels, assuming that 10 per cent of the attitude control system weight is charged to the oriented solar photovoltaic panel. Ten-watt radioisotope power sources are especially attractive as telemetry and tracking power sources for ranges to 1×10^6 miles for omnidirectional phaselocked communication links, because the complexity and reliability loss from the (CONTINUED ON PAGE 85)

Morphological Chart of Interplanetary Space Probe Power Systems

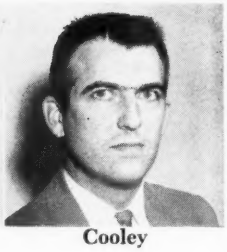
SOURCES	POWER CONVERTER	VOLTAGE AND FREQUENCY CONTROL
Power Sources	Photovoltaic (silicon solar cell)	Static inverter (DC/DC & DC/AC)
Solar	Photoemission	Semiconductor
Nuclear	High voltage—beta particle	Transistor
Radioisotope	Low voltage—photons	Silicon-controlled rectifier
Reactor	Thermoelectric	Vacuum tube
Energy Sources	Semiconductors	Thyratron
Electrochemical batteries	Diodes	Ignitron
Nickel-cadmium	Vacuum	Motor-generator set
Silver-zinc	Plasma	Frequency reference element
Fuel cells	Thermal boiler	Voltage reference element
Primary	Turboalternator	
Regenerative		
Chemical		
Liquid-propellant		
Solid-propellant		
Mechanical		
Spring		
Inertia mass		


Rosen

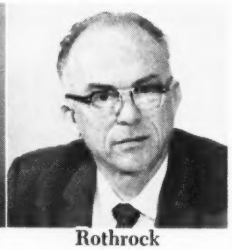
Mitchell


Tischler

Finger


Cooley

Hyatt


Rothrock

Much of the responsibility for adequate design, reliability, and utility of NASA's coming rocket vehicles rests with these leaders of its Propulsion Division (see listing below).

NASA—Men and giant rockets

Power for the national space program—booster rocket systems for space vehicles—finds a focus in the programs and project engineers of NASA's Propulsion Division

By John A. Newbauer

FOLLOW a line on the National Aeronautics and Space Administration organization chart – from the Office of the Administrator, T. Keith Glennan, past the Scylla of the Office of the Director of Planning and Evaluation (Homer Joe Stewart) and the Charybdis of the Office of the Director of Public Information (Walter Bonney) out to and through the Office of the Director of Space Flight Development (Abe Silverstein) and down to the Office of the Assistant Director for Propulsion (Abraham Hyatt)—and you will find this focus for NASA projects:

Rocket-Vehicle Development Program, Chief, Milton W. Rosen
- Delta Manager, Samuel Snyder
- Vega Manager, Milton W. Rosen (Acting)
- Centaur Manager, Milton W. Rosen
- Nova Manager, Richard Snodgrass (Acting)

Solid-Rocket Development Program, Chief, Elliot Mitchell
- Scout Manager, Elliot Mitchell

Liquid-Fuel Rocket-Engine Program, Chief, A.O. Tischler
- $1^1/_2$-Million-Lb Thrust Engine Manager, A. O. Tischler
- Second-Stage Vega Engine Manager, Oscar Bessio
- 6000-Lb-Thrust Storable Engine Manager, Oscar Bessio (Acting)
- Hydrogen-Oxygen Engine Manager, Melvyn Savage

Nuclear Engine Program, Chief, Harold B. Finger
- Nuclear Heat Transfer Rocket Manager, Harold B. Finger (Acting)
- Nuclear Electric Power Generation Manager, James E. O'Neill

Space Propulsion and Auxiliary Power Unit Program, Chief, William C. Cooley

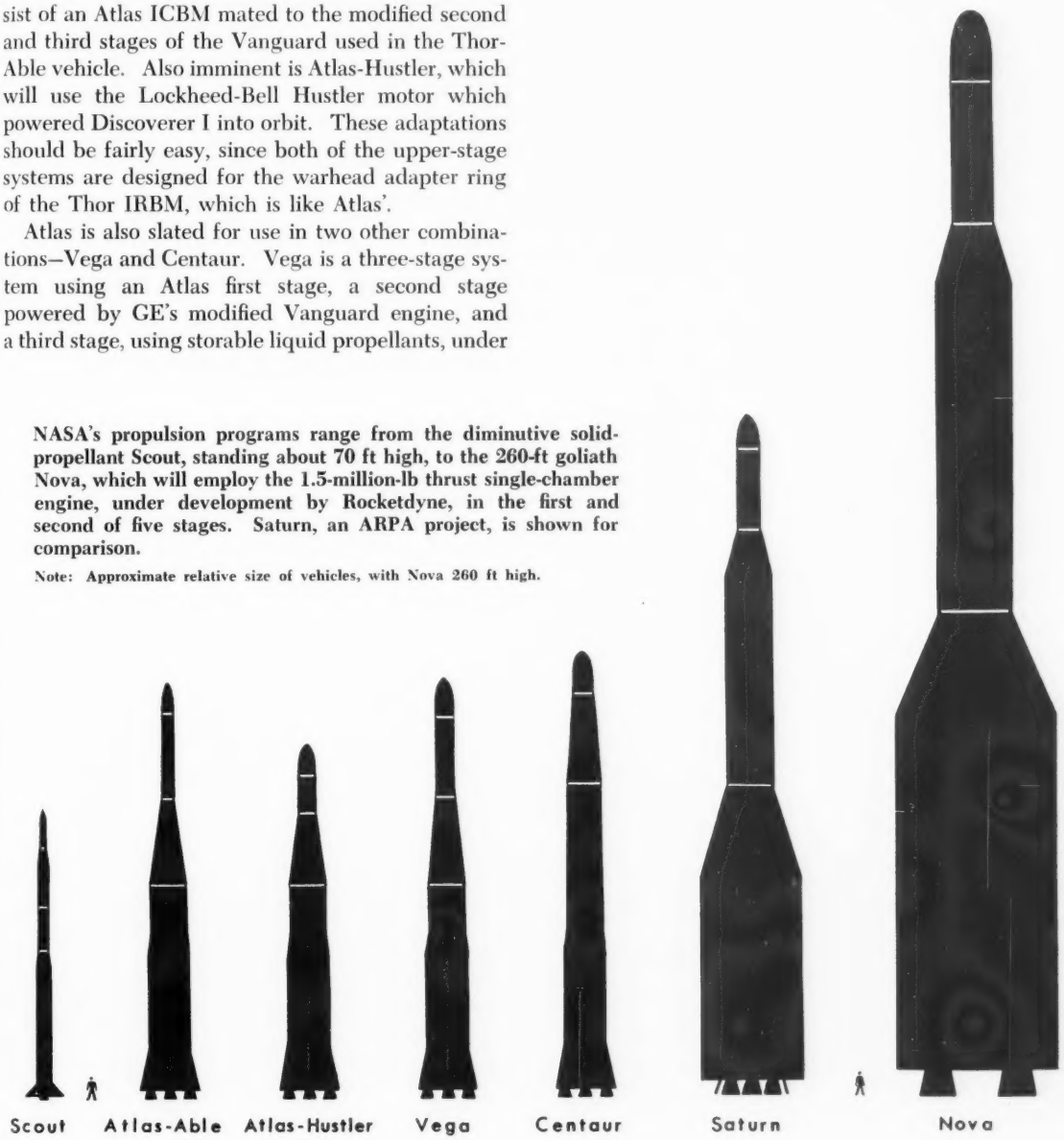
The sketch on the opposite page compares the major vehicles represented in NASA propulsion projects. Unveiled to Congress this spring, as the base of the national space program for the next decade, at the end of which nuclear rockets should become practical, the vehicle program looks like this. The Delta project, it should be noted, represents an extension of the Thor-Able series of rockets.

Scout will be NASA's utility research-package booster system. It will consist of four stages of solid-propellant motors — first stage, an Aerojet Senior; second stage, an improved Thiokol Sergeant; third stage, a new scale-up of the Vanguard third stage by Allegheny Ballistics Lab; and fourth stage, an ABL third-stage Vanguard motor. (Aerojet Senior was originally developed for the joint Army-Navy IRBM program but was shelved when the Navy undertook the Polaris project.) Scout will weigh about 35,000 lb, stand 70 ft high, and cost about $500,000 a copy. The system should be operational within a year.

Probably the first of the new series of boosters to see action will be the Atlas-Able. This will consist of an Atlas ICBM mated to the modified second and third stages of the Vanguard used in the Thor-Able vehicle. Also imminent is Atlas-Hustler, which will use the Lockheed-Bell Hustler motor which powered Discoverer I into orbit. These adaptations should be fairly easy, since both of the upper-stage systems are designed for the warhead adapter ring of the Thor IRBM, which is like Atlas'.

Atlas is also slated for use in two other combinations—Vega and Centaur. Vega is a three-stage system using an Atlas first stage, a second stage powered by GE's modified Vanguard engine, and a third stage, using storable liquid propellants, under development by JPL. Vega may also be used without a third stage. Centaur is identical to Vega, except that the second stage will be powered by dual Pratt & Whitney boosters using liquid hydrogen and oxygen. Vega and Centaur should orbit 6000 lb.

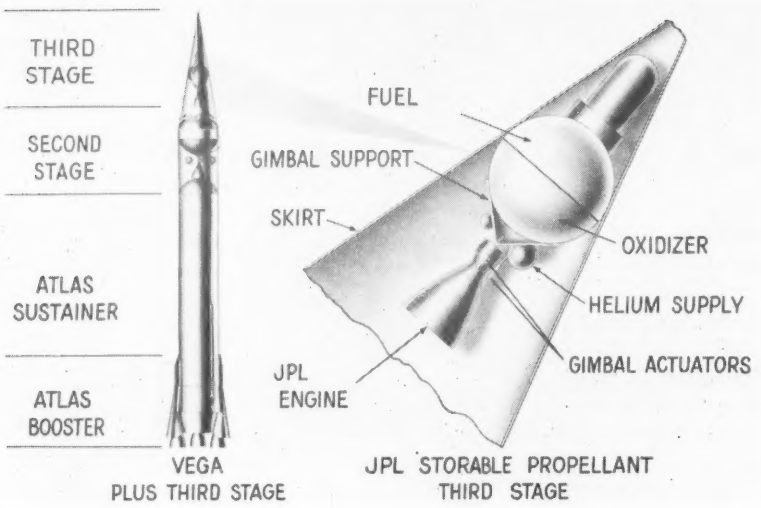
Nova and Saturn, the latter an ARPA project listed for comparison, are the biggest of the new booster systems. Saturn (also called Juno V by the Army) will be a four-stage vehicle using eight clustered Rocketdyne motors in the first stage to develop approximately 1.2 million lb thrust, a Titan booster of 300,000 lb thrust as the second stage, the Centaur high-energy motor as the third stage, and



NASA's propulsion programs range from the diminutive solid-propellant Scout, standing about 70 ft high, to the 260-ft goliath Nova, which will employ the 1.5-million-lb thrust single-chamber engine, under development by Rocketdyne, in the first and second of five stages. Saturn, an ARPA project, is shown for comparison.

Note: Approximate relative size of vehicles, with Nova 260 ft high.

Design Scheme for Three-Stage Vega



Vega, employing an Atlas booster as first stage, a modification of GE's Vanguard first stage as second stage, and the new 6000-lb-thrust storable-propellant engine under development by JPL, will give this country the propulsion capability evidenced by the launching systems for the Russian satellite Sputnik III and moon probe Mechta. If all goes well, this version of Vega should become available by 1961.

the 6000-lb-thrust JPL storable motor as final stage. Nova will be a five-stage rocket weighing about 4.5 million lb. First stage will be a cluster of four 1.5-million-lb-thrust single-chamber motors; second will be a single 1.5-million-lb-thrust booster; third and fourth will be high-energy motors of 80,000 and 15,000 lb thrust and the fifth will be the JPL motor. Nova will be able to put a 150,000-lb manned laboratory into 300-mile orbit and allow elaborate moon and space probes.

The propulsion program involves at present the development of five essentially new engines:

1. 1- to 1.5-million-lb-thrust single-chamber propulsion unit (kerosene and lox propellants), under development by Rocketdyne. The first experimental version of the engine has already been static-fired, and the propulsion unit should emerge from development by the end of 1963.

2. 80,000-lb-thrust propulsion unit (liquid hydrogen and lox), under development for more than a year, and scheduled to emerge in early 1963.

3. 20,000-lb-thrust propulsion unit (storable liquid propellants), still in design stage but expected to emerge by mid-1963.

4. 15,000-lb-thrust propulsion unit (liquid hydrogen and lox), under development by Pratt & Whitney Division of United Aircraft Corp. and expected to emerge during 1961.

5. 6000-lb-thrust propulsion unit (storable propellants), under development by JPL and expected to emerge by mid-1960.

The 34,000-lb-thrust second stage for Vega represents a modification of the GE first-stage engine for Vanguard; and the 190,000-lb-thrust engine for clustering as the Saturn booster represents a modification of Rocketdyne's standard engine for ballistic missiles, e.g., Thor, Atlas, and Jupiter. It can be expected that these engines are designed for the maximum of interplay in staging.

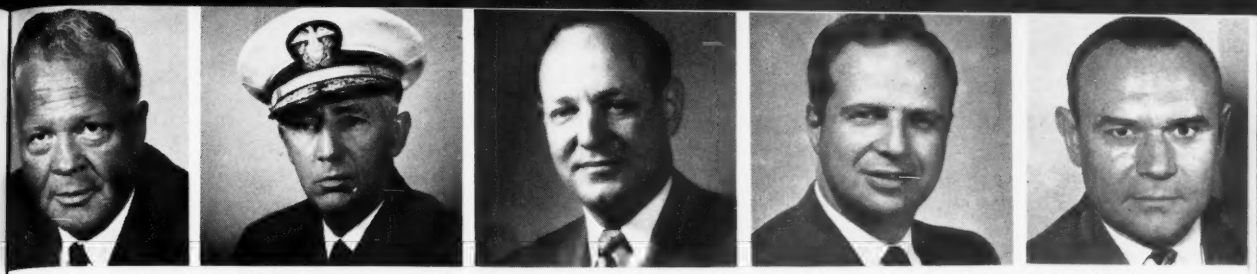
This development program, as presently seen, entails an investment of some $2 billion in less than a decade. Much of the responsibility for ensuring that this tidy sum produces well-designed and reliable rocket systems rests with the members of NASA's Office of the Assistant Director for Propulsion, i.e., Propulsion Division. These men are project engineers in a real sense of the term. Who are they and, briefly, what are their backgrounds?

Worked on High-Energy Fuels

Abraham Hyatt, head of the Propulsion Division, came to this position from Navy BuAer, where he was chief scientist and research analysis officer. He is noted for his work on high-energy fuels and on applied research which led to development of the Navy's Skystreak and Skyrocket research airplanes, the Lark and Polaris missiles, and the Navy's verticle-takeoff aircraft.

Here should be mentioned Addison M. Rothrock, scientist for propulsion in the Office of the Director of Program Planning, who served as assistant director for research for the NACA until being appointed to NASA. He has a broad background as a research engineer and administrator in combustion and propulsion studies with the NACA, having worked over 20 years at Langley and Lewis laboratories before becoming an NACA research director.

Milton Rosen, head of the rocket vehicle development program, and Vega and Centaur vehicle manager, hardly needs intro- (CONTINUED ON PAGE 87)



ARPA leadership pools long experience in industry, the military, and engineering science. From left, ARPA Director Roy Johnson, GE executive vice-president for 10 years before stepping into key ARPA role; Deputy Director Rear Adm. John E. Clark, USN, previously CNO's director for guided missiles; Asst. Director for Administration Lawrence P. Gise, previously assistant director of the AEC Division of Military Applications; Chief Scientist and Director of IDA George Sutton, previously manager of advanced design for Rocketdyne, an ARS president, and recently Hunsaker Professor of Aeronautical Engineering at MIT; and Director of Technical Operations Nicolas E. Golovin, long a government scientist and administrator, and before joining ARPA, chief scientist of White Sands Missile Range.

ARPA—Military space research agency

Agent of the Secretary of Defense, the Advanced Research Projects Agency provides the nation with means to insure efficient application of military resources to national defense requirements in space

THE ADVANCED Research Projects Agency is a unique organization in the Department of Defense, and it owes this uniqueness to the emergency that prompted its formation. The Sputniks alerted the nation to the importance of space and the Secretary of Defense to the need for a full-time, competent technical and managerial body of unusual responsibility and authority to direct DOD space studies and other high-priority advanced research efforts. ARPA was the Secretary's solution for insuring that the research capabilities of the Army, Navy, and Air Force would be integrated into an efficient program in a new era.

On February 7, 1958, Roy Johnson, then executive vice-president of GE, was chosen to head ARPA. He began to organize a staff for this new agency with the aid of exceptional prerogatives. He was authorized to acquire his own facilities, to contract directly for the performance of work assigned to him by the Secretary of Defense, and to issue orders directly on operational elements of the military departments for the performance of all or parts of ARPA projects. These projects covered military space technology, ballistic missile defense, and solid propellants.

Despite these broad powers, ARPA did not disrupt service facilities or installations. It did not acquire its own field laboratories (and there is no evidence that it intends to do so). Rather, its efforts were directed to focusing the capabilities of the services, industry, and academic institutions to explore and to solve problems under its cognizance.

During the past year, ARPA's responsibilities have involved administration of almost $500 million in funds. Through this substantial budget, ARPA has funded and managed satellite systems for communications, early warning, and navigation. It is directly concerned, furthermore, with development of controllable satellites and of maneuverable space vehicles. These diverse space systems have brought ARPA into the basic fields of propulsion, guidance and control, and ground environment on a very large scale.

Initiated Over 50 Programs

In the field of advanced research into future ballistic-missile defense systems, ARPA has initiated over 50 programs, some of a high-risk nature, to explore the routes to an effective system with a price tag the United States can afford. In solid-propellant technology, ARPA has authorized about 50 contracts to do the basic research required for breakthroughs in this important field.

The way in which ARPA conducts its business in all of these important fields can be inferred from the organizational chart on page 36. Through its small management and technical staff, ARPA seeks to insure that research in its assigned areas takes the fullest advantage of all defense capabilities. That is, proposals presented to ARPA by a single service or by an industrial firm may combine both strong and weak points, generally reflecting the

facilities and talent available to the proposer. The ARPA staff seeks to relate one proposal with another to identify the strong points in each case, and then select, if necessary, the appropriate service organizations or firms to do the job.

To date, ARPA has assigned its major projects to the Army Ordnance Missile Command, the Army Signal Corps, the Office of Naval Research, the Navy Bureau of Ordnance, and the Air Research and Development Command. These organizations, in turn, contract ARPA work with industries and educational and research institutions. The Secretary of the military department concerned and the Joint Chiefs of Staff are advised of the project work prior to the time of assignment by ARPA.

ARPA's major projects, it should be noted, originate in response to military requirements as stated by the Joint Chiefs of Staff. Through ARPA the Department of Defense seeks to achieve a blend of requirements and resources. This blend is developed by the ARPA staff.

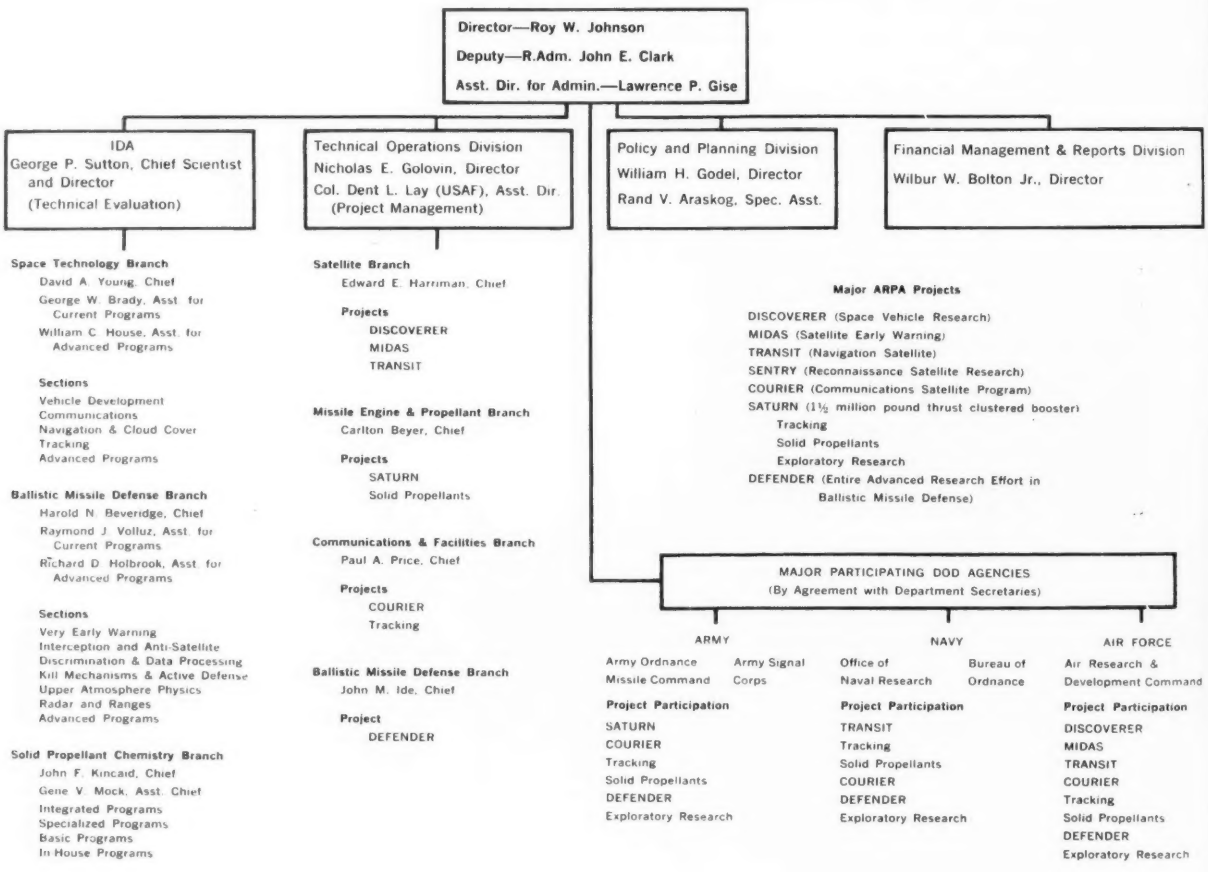
Roy Johnson's deputy is Rear Adm. John E. Clark, who had established himself as a missile manager in the Navy prior to his ARPA appointment. The assistant director of ARPA for administration is Lawrence P. Gise, who was formerly assistant director for military applications of the AEC.

The three ARPA operating divisions are Technical Operations, Policy and Planning, and Financial Management and Reports.

Keep Track of ARPA Projects

The director of the Technical Operations Division is Nicholas E. Golovin, formerly chief scientist at White Sands Missile Range. Under Dr. Golovin, approximately 18 program managers keep track, on a day-to-day basis, of ARPA projects. The director of the Policy and Planning Division is William H. Godel, formerly deputy assistant for special operations to the Secretary of Defense. His division is responsible for the integration of military requirements, national policy, and capabilities into ARPA long-range planning. The Financial Management

ADVANCED RESEARCH PROJECTS AGENCY

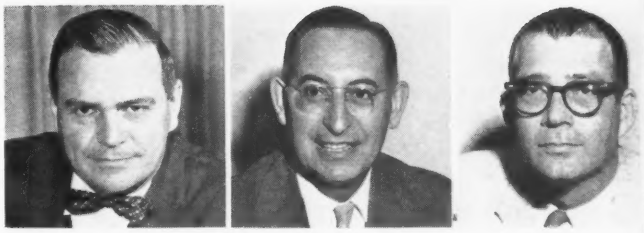


and Reports Division, headed by Wilbur W. Bolton Jr., provides a comptroller function for the Director.

ARPA's scientific and technical staff is furnished under contract with the nonprofit Institute for Defense Analyses (IDA). This group, consisting of approximately 35 scientists and engineers, serves in an advisory capacity to the agency. George P. Sutton, formerly Hunsaker Professor of Aeronautical Engineering at MIT and manager of advanced design at Rocketdyne, directs IDA and is also principal scientific adviser to the director of ARPA.

IDA has three branches—Space Technology, Ballistic-Missile Defense, and Solid-Propellant Chemistry—headed by the men shown on the chart on page 36. They immediately direct research analyses and experimentation, systems engineering and analyses of technical capabilities, development of new programs, evaluation of technical proposals, and interpretation of scientific data derived from various projects. The IDA scientific staff provides the high level of technical competence required to support ARPA decision-making.

ARPA has provided the Secretary of Defense and the nation with means for insuring the efficient application of military resources to our defense requirements in space. The ARPA budget for fiscal 1960 will reflect a higher total than the $450 million budget of 1959. This is but an indication of the fact that ARPA is relying successfully on its technical skill and accomplishments, rather than upon Sputnik pressure, for its continued operation

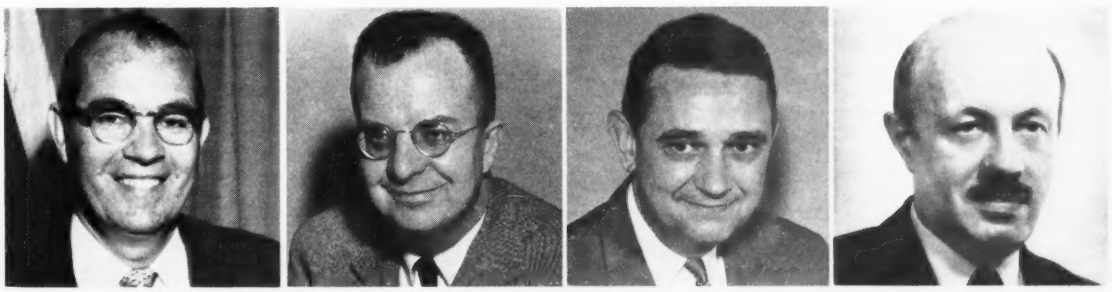


Heading IDA's three branches are (from left) David A. Young (Space Technology), a former engineering scientist with Aerojet-General in charge of liquid-propellant and nuclear projects; Harold Beverage (Ballistic Missile Defense), previously an engineer and laboratory manager for Raytheon Co. and various of its subsidiaries; and John F. Kincaid (Solid-Propellant Chemistry), combustion and propellants specialist, previously a research supervisor with Rohm & Haas for 12 years.

No Evidence of Overcontrol

There was, naturally, concern on the part of the services that ARPA would restrict the military departments from pursuing the many activities that might be required to fulfill military missions in space. There is no evidence that ARPA has overcontrolled the services nor that it intends to do so. Furthermore, by its own admission, ARPA does not intend to retain responsibility for projects once they have passed the basic research and development stage. This apparently means that once a device or system is ready to go into operation with a minimum of research and development improvements, the Secretary of Defense will assign it to a service or joint command.

ARPA's chief concern is developing forward-looking programs. It is dedicated to basic research and development of systems which can become part of the operational future of the military commands. ARPA came about through the need for national direction in military research. It is giving good evidence of supplying this direction, unbiased focus on problems, and long-range planning.



The four branches of TOD are headed (from left to right) by Edward E. Harriman (Satellites), a career civil servant who has been scientific adviser to the DOD Director of Guided Missiles and senior systems engineer for Air Weapons, Navy BuOrd; Carlton M. Beyer (Missile Engine and Propellants), for 10 years a senior engineer and project manager for NEL and later a division head in DOD's OGM; Paul A. Price (Communications and Facilities), previously assistant chief of the R&D Division of the Office of the Chief Signal Officer (Army); and John M. Ide (Ballistic Missile Defense), distinguished physicist and authority on undersea warfare.

The orbital post office

Satellites, microwave repeaters, and high-speed photoelectric printing methods make possible intercontinental transmission of facsimile letters among post office networks in a matter of seconds

By Sidney Metzger

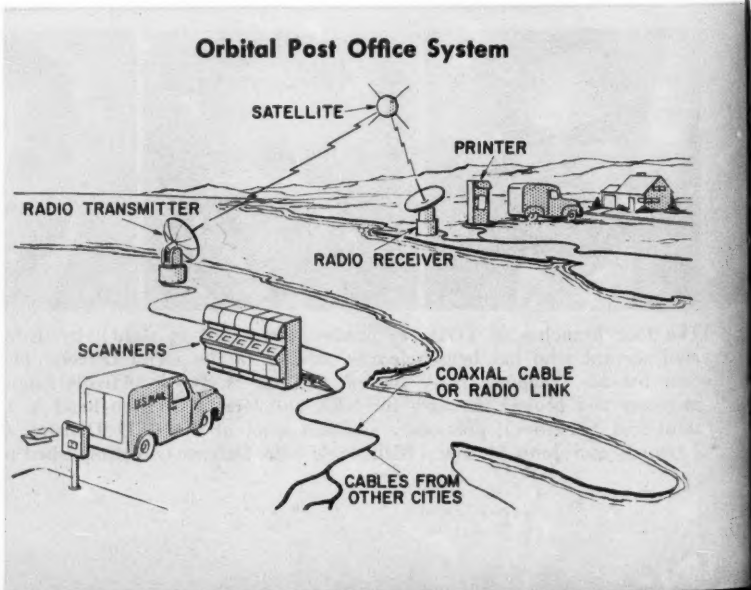
RCA ASTRO-ELECTRONIC PRODUCTS DIV., PRINCETON, N.J.

IT IS ALL but common knowledge now that satellites make possible over-the-horizon communication through ground-station links. RCA studies suggest that this mode of communication could enhance postal service between continents. In particular, our studies indicate that major post offices in this country and Europe could be interlinked by a satellite communications system based on a two-way microwave frequency circuit and photoelectric facsimile transcribing and printing devices already partially developed.

Microwave frequencies (1000–10,000 mc) offer negligible ionospheric interference with transmission and wide bandwidths capable of handling high-speed facsimile signals. It should be mentioned that present high-frequency (3–30 mc) radio systems, which reflect signals off the ionosphere to achieve over-the-horizon communication, offer only a thousandth of the bandwidth required for rapid facsimile transmission.

Such a satellite communications system—an Orbital Post Office—would permit transoceanic transmittal of a facsimile letter in a matter of seconds. Most of the time to deliver a letter would then be taken up by the postman. Handling only first-class letters and airmail between the U.S. and Europe, the system would eliminate the more

Sidney Metzger is manager of communication engineering at Astro-Electronic Products, where he was, among other things, in charge of supplying the satellite and groundbased radio equipment for Project Score, the "talking satellite." He received a B.S. in electrical engineering from New York Univ. in 1937 and an M.E.E. from Brooklyn Polytechnic in 1950. During this period, and previous to 1954, when he joined RCA Labs at Princeton, he was first a radio-communications engineer for Army Signal Corps Labs and then, for 10 years, in charge of commercial and military multiplex microwave systems for Federal Telecommunications (now IT&T) Labs. He transferred from RCA Labs to his present position in 1958.



than 55 tons of mail delivered by ship and plane between the two continents daily. There is thus a distinct economic incentive to explore the orbital post office. A possible drawback would be some loss of privacy and personal distinctiveness in mail.

But our purpose must be first to inquire into the technology that would make the orbital post office possible.

The basic method of operation of the U.S.-Europe Orbital Post Office would be as illustrated below. There would be one ground-radio station in the U.S. and one in Europe which would communicate via a satellite repeater. Each ground station would connect to some 25 major post offices on its continent via a two-way, 5-mc circuit provided by existing types of facilities, such as radio relay links or coaxial lines, as now used for TV transmission. Each of the major post offices would convert "hard" paper copy into electric signals, and vice versa. Transatlantic mail would be written on a special $8^1/_2$- by 11-in. form similar in appearance to the WW II V-mail letter. The names of the major post offices (with a blank area adjacent) would be printed along one edge of the form, so that the sender could mark the major post office nearest the letter's designation.

From the local post office, letters would go to the nearest major post office, where they would be opened and placed in a scanning device for conversion into electrical signals and simultaneous transmission through the circuit, over the satellite relay, and hence to the opposing continent, where the "major post office" designation would be recognized and the letter automatically converted into hard copy. It would be automatically folded and sealed, and delivered via the usual channels.

Let us look at this system in more detail.

First, what would be the communicating capacity of a 5-mc bandwidth radio system? Assume that each letter consists of one $8^1/_2$- by 11-in. page, of which an area 8 by 10 in. is used, with a resolution of 100 lines per inch, and that printers used to convert from electrical signals to hard copy have a combined capacity of 10 letters per second. These figures yield a total capacity of 600 million letters per year over a two-way circuit which operates 95 per cent of the time. This allows for a reasonable margin over the 1957 load of 428 million letters.

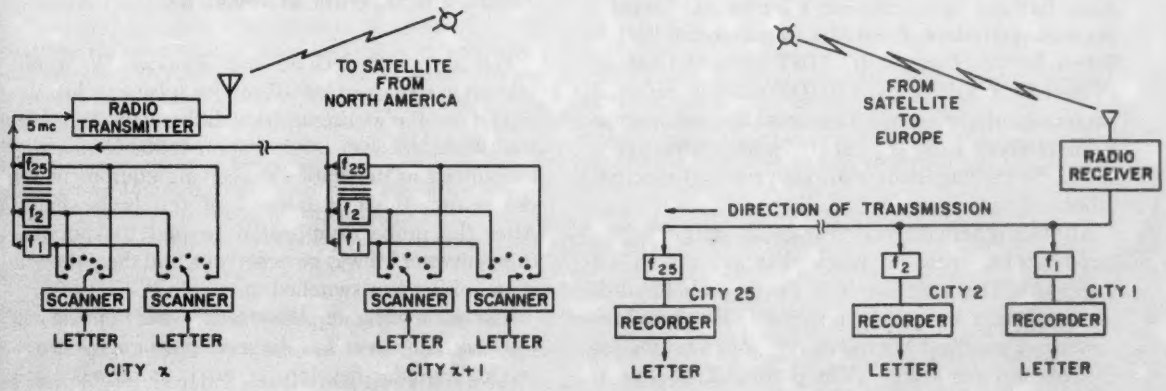
Passive Repeaters Proposed

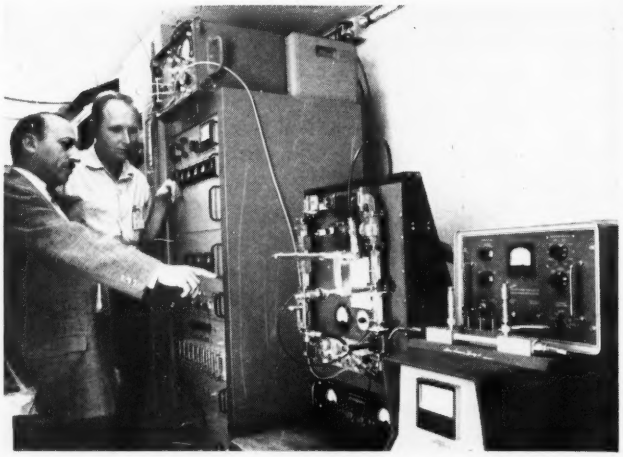
Passive repeaters have been proposed for a wideband (5-mc) transatlantic circuit by J. R. Pierce and R. Kompfer (Proceedings of IRE, March 1959). Such a circuit could be provided by putting two dozen metallized mylar spheres 100 ft in diameter into a 3000-mile-altitude polar orbit. The spheres, including the gas bottle needed to expand them when they get into orbit, would weigh about 100 lb each. They would be randomly spaced around the orbit, and one would be in common view of a station in Newfoundland and one in Scotland about 99 per cent of the time. The stations would communicate by pointing their antennas at the same sphere, automatically tracking the sphere, and transmitting signals which would arrive at the other station by reflection from the sphere. Such a system would operate at 2000 mc, with 85 kw of transmitter power.

A ground-station antenna would be a 50-ft-diam parabolic reflector steered by a computer. This antenna would have a beamwidth of about $^1/_4$ deg. Two such antennas would be needed at each ground station, one to acquire a newly arriving satellite while the other is working via a departing one.

The antennas represent the largest item of cost in the ground equipment. Fortunately, additional circuits may be provided (CONTINUED ON PAGE 48)

Block Diagram of U.S.-Europe Orbital Post Office System





Left, ABMA's tracking station on Monte Sano Mtn. and, right, parametric amplifier as installed in the station. See page 44 for block diagrams of station and amplifier.

A parametric amplifier in space-probe tracking

ABMA and IT&T teamed a modest "quick-look" tracking station with a 1-db parametric amplifier to track Pioneer IV 200,000 miles

By William C. Pittman

ARMY BALLISTIC MISSILE AGENCY, HUNTSVILLE, ALA.

INCIDENT to the launching of Pioneer IV, which passed the moon on the way into heliocentric orbit March 4, was a dramatic field demonstration of a solid-state device certain to play a large role in future space communication systems—the parametric, or junction-diode, amplifier. Introduced into Army Ballistic Missile Agency's "quick-look" receiving station on Monte Sano Mtn., a parametric amplifier under development by IT&T allowed tracking Pioneer IV to a distance of 200,000 miles on radiated power of only 180 mw. This amplifier had a noise figure of about 1 db, as compared with a noise figure of 7.5 db for amplifiers with conventional electron tubes.

ABMA's otherwise modest tracking station is pictured above, with its block diagram shown on page 44. The antenna is a 14-ft parabolic dish mounted on a temporary pedestal. The basic receiver is a modified Microlock developed by the Jet Propulsion Laboratory. (The particular model employed in the ABMA station was manufactured by Hallamore Electronics.) With the 108-mc preamplifier, the station has a sensitivity of minus 147 dbm (for Doppler data only).

Adapted to Operate at 960.05 mc

When it was decided that Pioneer IV would telemeter signals of 960.05-mc frequency, a kit, designed by Radio Engineering Laboratory to adapt the 108-mc receiver for operation at 960.05 mc, was introduced in the station's receiving equipment for use during the first interval of the probe flight. After the probe disappeared beyond the horizon, this converter kit was switched out, and the parametric amplifier was switched in.

The parametric amplifier itself, which appears in the photo above and is diagramed on page 44, was originally under develop- (CONTINUED ON PAGE 44)

Kodak reports on:

clear, competitive vision in the 2-8μ region of the infrared . . . adjusting at the lab instead of in the sky . . . an occasional dunk for the new oscillography

"Irtran"—ask for it by name

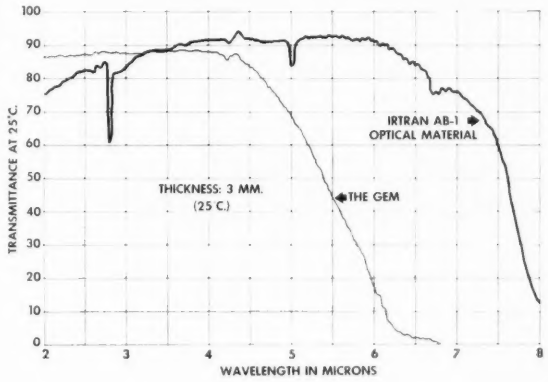
By dint of perseverance, knowledge, inspiration, judgment, experience, ambition, ingenuity, and the concentrated power of many clear heads and skillful hands, we have learned how to mold, grind, and polish a certain substance to make rugged, optically precise windows and domes that transmit efficiently the 2-8μ region of the infrared.

Around this whole package of technology we put a convenient string and tag it with a new trademark, "Irtran." Immediately—so robust is the American economy—we find ourselves in competition with some excellent fellows who also possess the above-named qualities and who make a most excellent infrared-transmitting optical material—a gem, synthetic but true, with a gem's name. To spell that name out would be as unmannerly as it is unnecessary for those caught up with infrared-actuated swords and plowshares.

Rather, we want such cognoscenti to spell out *Kodak Irtran Optics, Type AB-1.*

They cost a lot less than the gem makers have a right to ask.

They see clearly through the 3-5.5μ windows of the atmosphere.



They stay clear to at least 800°C instead of permitting Herr Kirchoff's law to blind them by their own emissivity.

They have a refractive index of only 1.301 at 6.7μ, paying scant tribute to M. Fresnel's celebrated equation about reflection losses.

They survive all the high temperature, thermal shock, weathering, humidity, and abrasion that the current tests for swords require.

Type AB-1 is only the beginning of the *Irtran* business, we suspect. Quartz was fine when lead sulfide was the practical detector; PbS quits at 4μ. Now the longer wavelength sensitivity of cooled lead selenide, lead telluride, and indium antimonide has outrun the transparency of good old quartz. Soon the boys will be banging on the 8 to 13μ window of the atmosphere. For lenses with optical power they'll want infrared-transmitting material of higher refractive index. *Type AB-1* may be only the beginning.

With what excitement the specifications for us to quote on will be drawn up and shot off to Eastman Kodak Company, Special Products Division, Rochester 4, N. Y.!

Film to view a planet by

Speaking of fresh approaches to old problems, let's get rid of complex and heavy equipment that an airborne (or better) vehicle on photographic duty must carry to adjust exposures as it moves into different illumination conditions. Let's expose the whole roll of film at the same settings and forget the light level. Let's make the adjustment during processing at the lab, not zipping through the sky.

We now sell a film you can treat that way—*Kodak Plus-X Aerographic Film.**

First thing after it comes back from the ride is to put it through a certain developer for 7 minutes. Inspect. Cut off the part of the roll that shows printable image and put the rest through *Kodak Developer D-19* for 2 more minutes. Inspect. Cut off whatever part of the roll still shows no printable image and put that part back in the *D-19* for another 10 minutes. Whatever you don't have by then, you just don't have. If there are regrets, you can sadly conclude that standard aerial emulsion speed, even with spectral sensitivity extended to 710mμ as it has been in the new *Plus-X*, is inadequate for what you were trying to do.

We do have one, *Kodak Tri-X Aerecon Film*, that's quite a lot faster. It doesn't offer as big a definition boost as has been built into *Plus-X*, nor does it tolerate fishing in the developer for the proper effective emulsion speed.

On the contrary, we sort of feel that the brightest prospects for the future of photography to see a planet by lie in films *slower* than the new *Plus-X*. Trading in film speed for film definition strikes us as a good bargain. We suspect that with recent advances in lenses, image movement compensators, and vibration control, the customers don't need as much film speed as they have been used to. We know where we can lay hands on some slow aerial films of astounding definition. The exposure index-by-development technique works very well on them.

In youth you learned to develop paper prints by inspection. This is a different principle, and the inspection is by infrared. You'll need plenty of advice. Write to Eastman Kodak Company, Government Sales Division, Rochester 4, N. Y., for encouragement.

To permanize the unusual

Three good instrument manufacturers have been pushing for all they are worth a type of oscillograph that puts out a visible record instantly without chemical processing. Maybe you have one or a bank of them. They're terrific. They use *Kodak Linagraph Direct Print Paper.*

Occasionally—maybe often—you get a record that you wish had the long life that chemical processing gives. Now you can have your cake and eat it.

To offset such an old saw (an infelicitous one, moreover, to employ in discussing a prepared powder which so readily dissolves in a gallon of hot water), we have gone to the trouble of manufacturing a new word, "Permanize," as in *Kodak Linagraph Permanizing Developer.* Dunk as directed, fix, wash, and dry. No darkroom needed.

If your usual source of Kodak Linagraph Papers *cannot supply it, drop a sharp note of reproof to Eastman Kodak Company, Photo Recording Methods Division, Rochester 4, N. Y.*

*Down, boy! You can't have this emulsion yet on 16mm, 35mm, or sheet film. There are honest technical reasons for this, but you have to work in a film factory to appreciate them.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Kodak
TRADEMARK

Manned Outposts in Space

(CONTINUED FROM PAGE 23)

Outpost III consists of two life-support units at the far end from the reactor, a laboratory for low-g experiments near the hub, and an equipment and storage unit at the reactor end. In contrast to the other two stations, Outpost III would have a closed oxygen cycle (algae/gas-exchange system) and, for experimental purposes, a closed waste cycle (algae/food-waste exchange system). Principal data for Outpost III are given on page 23.

Some principles on which Outpost station design was based can be summarized as follows:

1. Space stations should employ a minimum number of personnel consistent with the functions of the station, because humans are the most expensive commodity in any extraterrestrial base which is not self-sustaining. An additional justification for making a determined effort to reduce crew size lies in the fact that man contributes through his brain *qualities*, rather than his physical capabilities, whereas automation has provided us with an adequate technology to handle all "stupid" (i.e., narrow, invariant, specialized, repetitive, automatic) operations. For intelligence functions (supervision, control, checkout, evaluation, discrimination, judgment, etc.), only a few well-trained, alert brains, provided with maximum comfort and safety, are needed.

2. A number of smaller life-support units is preferable to one large unit, for safety in case of a sudden leak of significant dimensions. Structural analysis shows that it would be very difficult to maintain the internal structural integrity of a large unit, subdivided by straight floors, in the case of air-drainage when it becomes necessary to isolate the damaged section. Special air-lock cylinders connecting smaller units can more easily, safely, and reliably be closed to isolate quickly the damaged unit, while still maintaining the comfort and gas-dynamic advantage of large total volume. For potentially hazardous manipulations, the endangered unit can easily be isolated. In the case of significant damage or wear and tear, a unit can be replaced more conveniently. For this reason, design of Outpost III as a sausage-string is not a necessary evil, caused by limited payload capacity, but rather represents adherence to a basic principle of life-support system design in all types of orbital and inter-orbital vehicles. In the case of Outposts I and II, it was not advantageous to subdivide the small life-support system.

3. Cylindrical, dumbbell, or paddle shapes are particularly desirable for space stations for a number of reasons. They are more compatible with the principle of individual life-support system units than are spherical, disk-shaped or wheel-shaped forms (except for much larger satellites than considered here). The distance of the life-support system from the center of mass can be made very large, while still retaining a relatively small space station, easy to establish and supply. The large distance also assures very favorable ratios of centrifugal to Coriolis acceleration, which will greatly add to the comfort of the crew. By means of booms or cables, the distance from the center of mass can be varied as desired. Finally, damaged and worn out units can more easily be separated from the system and replaced.

Required Orbits

Next, let's examine briefly the orbits which Outpost stations would require, both from the standpoint of missions to be performed and ground support.

The structure of the Great Radiation Belt approximates a ring roughly symmetrical to the earth's geomagnetic axis. Therefore, if the Outpost satellite is to avoid the radiation belt, it must stay below approximately 350 n.mi., regardless of its orbital inclination to the equator. At an altitude of 310 n.mi., the satellite would make 15 sidereal revolutions in 24 hr.

To minimize the ground support system, it appears desirable to avoid precessing orbits. This leaves polar and equatorial orbits as alternatives. Of these, the equatorial orbit offers greater accessibility, higher tolerances in the actual period and eccentricity of the satellite orbit, greater circularity in the first place, since the earth does not appear to be a triaxial ellipsoid, and greater safety from corpuscular radiation for the given altitude limit, because the polar regions with their inclined geomagnetic lines of force, offering less resistance to cosmic radiation and their auroral particle streams, are avoided.

Therefore, equatorial orbits would appear preferable for the first Outpost stations with crew training, equipment development, and other biological and technological objectives. For later stations, with meteorological and communication assignments, polar orbits would be more attractive.

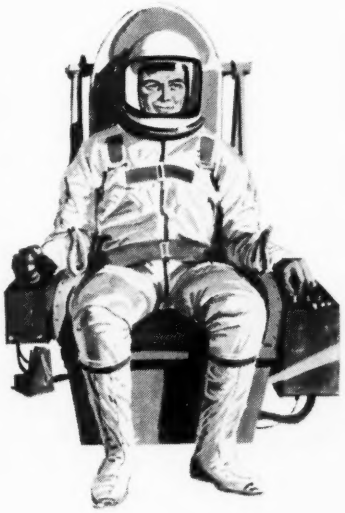
The lifetime of an Outpost space station at 300 to 350 n.mi. appears adequate for only occasional orbital adjustments. Outpost I, weighing 15,000 lb, has a lifetime of some 2 years at 310 n.mi. altitude (assuming atmospheric data corrected by Sputnik observations, C_D=2 and an integrated average of 0.75 of the broadside area). After one year, the station will have fallen to the 260 n.mi. level. It requires a total velocity of 190 fps, transferred by means of two horizontal impulses at 250 and 310 n.mi., to adjust the circular orbit back to 310 n.mi. altitude. Assuming an ideal velocity of 250 fps, specific impulse of 300 sec, and station weight of 15,000 fps, the propellant cost of this yearly maneuver is 400 lb.

With an equatorial orbit and an equatorial launching site, the ETO system can be handled with one site, assuming at least two launching complexes. The station's orbital elements will be known precisely after the launching of an intial reference body, so that the ETO vehicles do not require line-of-sight contact when taking off. The coasting time to the station's orbit is about 45 min for elliptical ascent, that is, half the station's period. Thus, during most of its coasting, the ETOV will have line-of-sight connection with the station and can be guided in by it, thereby simplifying the frequently overrated "rendezvous problem" even further.

From an equatorial base, at least 15 daily launching opportunities are available. The same number of opportunities exists from nonequatorial stations, for example, the Atlantic Missile Range, but the ascent is more expensive by about 12,000 fps. Such an increase in performance requirement will hardly be acceptable in the near future for any vehicle. In fact, if no equatorial launching site is constructed, the establishment in an equatorial orbit of space stations even as small as Outpost II must be postponed until a 1.5-million-lb-thrust booster, together with an adequate set of upper stages, is developed to reliable operational status.

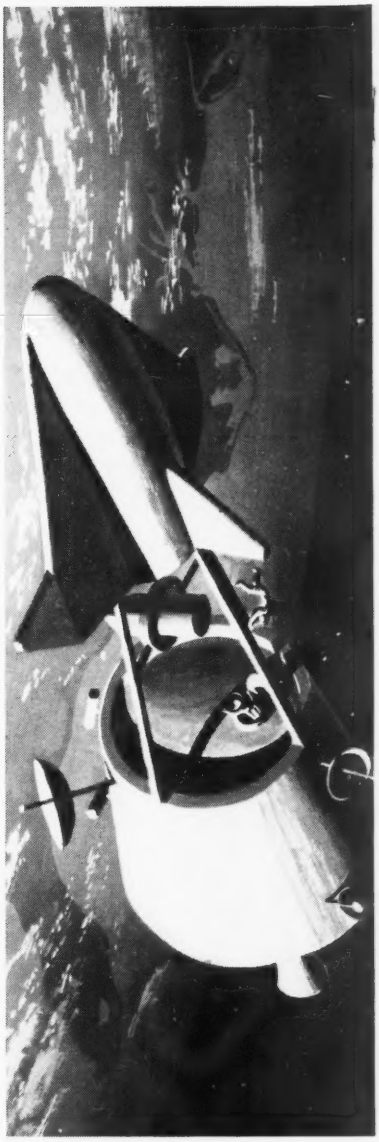
Alternatively, inclined precessing orbits must be accepted. For example, for a 30-deg inclination, the rate of precession of a 310 n.mi. orbit is about 6.7 deg per day (period of precession 54 days). In this case, the station would be physically accessible from the Atlantic Missile Range once daily, but at varying degrees of inclination.

Additional nonequatorial possibilities exist, especially with floating, mobile launching sites, but none of these is as favorable as an equatorial launching site. If an equatorial launching site were equipped to handle polar launchings as well, such a site, together with the Pacific Missile Range, would provide adequate accessibility to space stations in polar orbit.



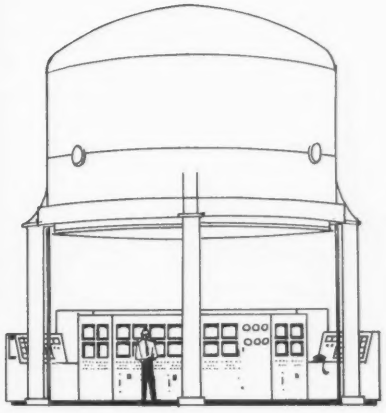
The man:

...a U.S. airman-engineer—carefully selected through rigorous test procedures from Military personnel. He will have the combination of mental acuity, superb physical condition and emotional stability necessary for pioneering in space exploration.



The mission:

...satellite observatory—a vehicle arrangement similar to this could orbit a three-man astronomical crew for several weeks. Empty fuel tank is used for living quarters. Nose section serves as re-entry vehicle for return to earth. The astronomical telescope is gimbal-mounted. External equipment shown is mounted after orbit has been attained.



The means:

...Space projects are accelerated by research equipment like the Douglas high-altitude chamber at Tulsa, largest in the U.S. In it, space environment problems can be worked out under near-operational pressure conditions, shortening the time required for development.

Depend on DOUGLAS

The Nation's Partner in Space Research

Parametric Amplifier

(CONTINUED FROM PAGE 40)

ment by IT&T for scatter communication work. It consists of a variable-capacitance silicon diode, with capacitance varied at an X-band frequency rate by a klystron-pump frequency generator. The input frequency at L-band is first converted to a lower-sideband frequency with a low-noise gain, and then converted back to the appropriate i-f frequency with a conventional X-band mixer.

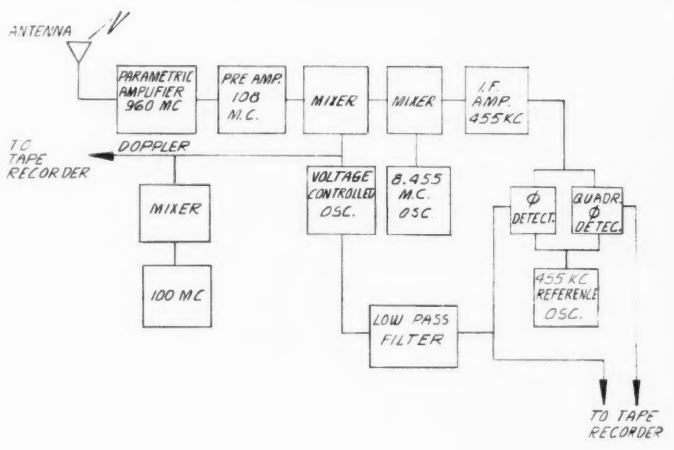
It will be noted from the block diagram shown below that an additional parametric converter is included in the system to translate the L-band signal from the reference oscillator to an appropriate X-band frequency. This scheme provides an i-f signal frequency independent of variations in the klystron-pump frequency. The 70-mc signal is converted, by an additional mixing process, to 108 mc for the preamplifier in the receiver. The 70-mc i-f frequency was employed in troposphere scatter circuits operated by IT&T.

Since modification of a laboratory model of the amplifier was started only a few days before the flight of Pioneer IV, an adaption was sought that would fit the unit to ABMA's tracking facility in the shortest time. It was decided jointly by IT&T and ABMA to add an additional mixer to convert the 70-mc signal to 108 mc, rather than modify the reference oscillator to yield the 108-mc signal directly. The reference oscillator employs a crystal at the present time, but this may be replaced by a molecular frequency standard designed by the National Company.

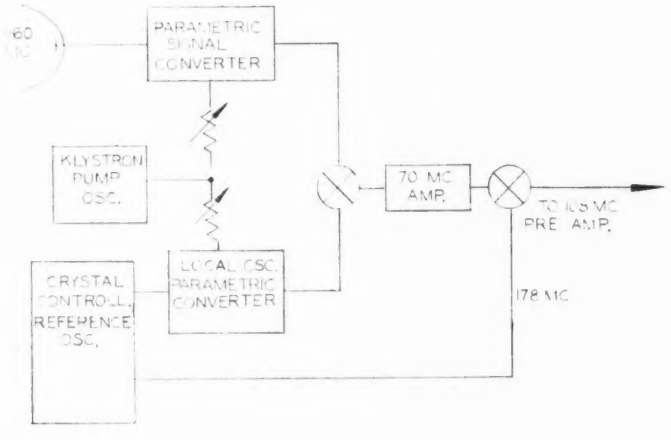
The ABMA tracking station was originally established as a "quick-look" facility to provide ballisticians with immediate data on the performance of the upper stages of Jupiter-C satellite vehicles launched from Cape Canaveral. The receiving facility, located on Monte Sano Mtn., can pick up a space vehicle above the radio horizon about 2 min after the launching at Cape Canaveral.

In addition to this kind of tracking, the ABMA station has proved a useful tool in propagation research. Scientists of the U.S. Army Signal Corps, the Ionosphere Research Laboratory of Pennsylvania State Univ., and government agencies have received station tracks of both Russian and American satellites. These records have provided valuable new information on the Faraday rotation of an electromagnetic wave propagated through the ionosphere in the presence of a magnetic field, and other ionospheric effects.

Block Diagram of ABMA's Monte Sano Tracking Station



Block Diagram of IT&T's Modified Parametric Amplifier



Field Laboratory Provided

The ABMA station also provides a field laboratory for evaluating advanced electronics in space communication systems. The Radio Frequency Development Section of the ABMA Guidance and Control Laboratory is evaluating, for instance, other schemes of parametric amplification employing electron tubes and ferrites. Recent discussions with Zenith engineers have shown that the fast-wave parametric amplifier invented by Robert Adler can be designed to operate at 960.05 mc with a noise figure of 1 db. It is likely, therefore, that field tests of this unit will be made in the near future.

A unique combination of engineering and scientific skills, coupled with production ability . . . plus more than two decades of continuous development and production of newer and better airborne instruments – over 400,000 reliable guidance controls delivered – these are the reasons why Whittaker Gyro instruments are operational on many of the nation's major missile programs. From a simple gyro to complete stabilizing systems . . . Whittaker can provide the latest in design.

Check These Advantages In The New Whittaker Sub-Miniature Rate Gyro!

- reliable performance from – 65 F to 400 F
- only ¾ inch diameter – 2 inches long
- non floated – eliminates fluid expansion problems
- quick start – no heater necessary

For additional information on the Sub-Miniature Gyro – on any specialized control components or systems . . . write today for technical data.

Floated rate gyros / Directional gyros
Vertical gyros / Spring energized gyros
Auto-pilots / Stable platforms / Rate switches

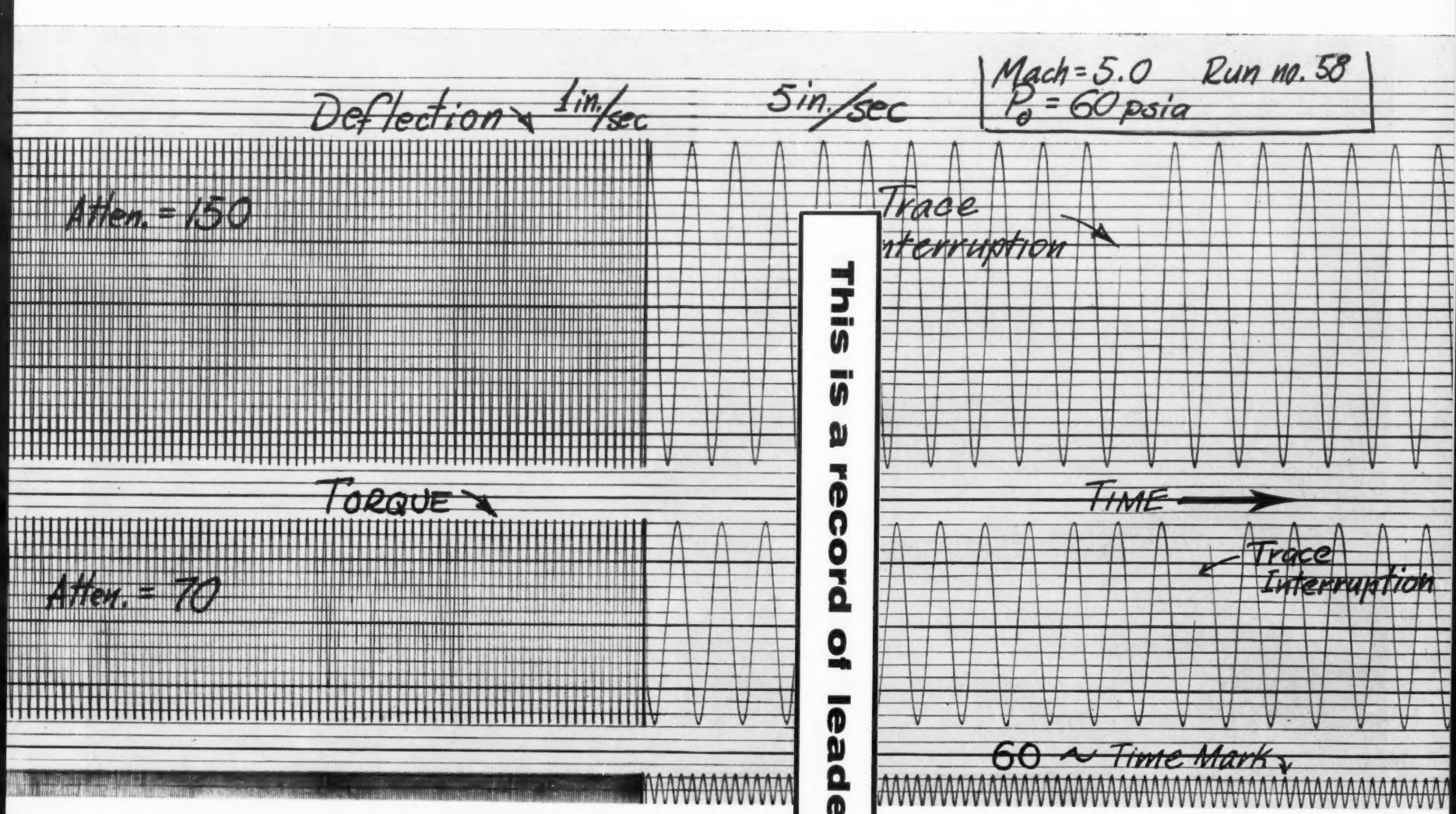
400,000

REASONS WHY WHITTAKER GYRO IS FIRST IN ADVANCED CAPABILITIES

"A Guide To Better Flight Controls"

WG

WHITTAKER GYRO
DIVISION OF TELECOMPUTING CORPORATION
16217 LINDBERGH ST., VAN NUYS, CALIF. PHONE: TRIANGLE 3-1950



Honeywell 906A Visicorder record, actual size. Note longitudinal grid lines and trace identification interruptions.

This is a record of leadership

These studies of aerodynamic damping coefficients on an airframe were made by engineers at ARO, Inc. They were conducted in the Gas Dynamics Facility at the U.S.A.F.'s Arnold Engineering Development Center, Tullahoma, Tennessee, wind tunnel center of the Air Research and Development Command.The studies were directly recorded on a Honeywell 906-A Visicorder.

The problem: To measure damping-in-pitch derivatives for a clipped-delta-wing-body configuration over a Mach number range of 2.0 to 5.0 so that these measurements could be compared with the Mach number trend predicted by theory.

The set-up: A model of the delta-wing body, mounted on its cross-flexure pivot support, was forced to oscillate through a linkage by an electro-magnetic shaker. Resistance strain gauges were bonded to the input torque member and to one of the pivot supports. These gauges supplied torque and displacement signals through a carrier amplifier to two galvanometers in the Visicorder. An oscillator, driving a third galvanometer, established a time base for the oscillogram.

The values discovered through this forced-oscillation balance system experiment showed some discrepancies from values predicted by theory, because the theory pertained to simpler bodies than that used in the tests. The experiments provided a new set of data which will result in more accurate predictions for future design.

in aerodynamic research

T. A. Woodard, Jr., ARO, Incorporated, instrument technician, operates the Visicorder in the measurement of aerodynamic damping coefficients.

The Honeywell Visicorder is the pioneer and unquestioned leader in the field of high-frequency, high-sensitivity direct recording oscillography. In research, development and product testing everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new accessory units.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin
Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

Honeywell

Industrial Products Group

MATHEMATICS

At Los Alamos applied mathematics finds its proper role as an essential tool of scientific inquiry. Problems range over such challenging areas as hydrodynamics, stochastic procedures, numerical analysis and the logical design of computers. And mathematics is only one of the many scientific activities in which trained men and women with imagination find stimulating opportunities in the Laboratory of the future.

For employment information write to:
Personnel Director
Division 59-71

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

Orbital Post Office

(CONTINUED FROM PAGE 39)

over the same antenna by using additional frequencies for the various circuits and suitable filters to avoid interaction between the transmitters and receivers. Thus, the antenna cost may be shared by TV, mail, telephone, and telegraph services.

It is also possible to use a single active satellite at an altitude of about 22,300 miles in an equatorial orbit. This satellite would have a period of 24 hr and would appear fixed in space over the earth. For this application a longitude midway between U.S. and Europe would be used.

Using the same frequency and ground antenna as before, a satellite with a nondirectional antenna would need a transmitter power of only 1 watt to achieve the same results. This satellite would not need to have its attitude stabilized with respect to the earth, but it would have to have provision for orbital correction by control from the ground.

Because the repeater would have to be very reliable, it would be desirable to install four complete amplifier packages (two for each direction of transmission), only one of which would be in use at a time in each direction. For switching from one amplifier to another, several auxiliary transistorized radio receivers would be used, operating in the VHF range (100 to 300 mc). It is estimated that this satellite would weigh several hundred pounds and could be launched by an Atlas or Titan plus upper stages.

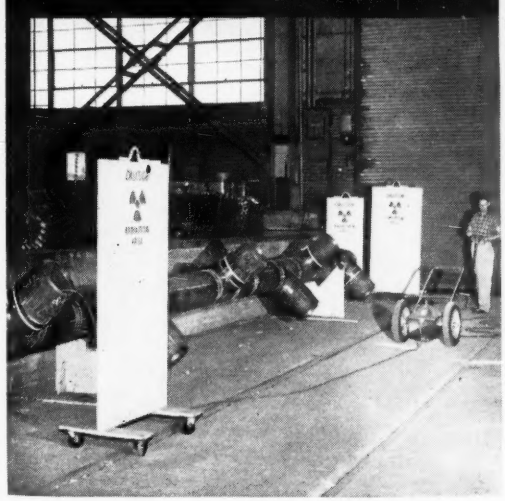
Initial estimates indicate that the cost of this satellite, including the rocketry and an allowance for failures, would be reasonable if a life of 1 year could be obtained. It is not yet quite clear which system—the passive or the active—would be best suited for the job.

Look now at the ground station in terms of the letter itself. We have two phases of operations: Conversion from hard copy into electrical signals (and the reverse operation) and the electrical transmission system from the major post offices to and from the ground radio stations.

A standardized letter form must be used, and must be opened for conversion into electrical signals. An important question is the public's reaction to these restrictions in peace time. Business firms might not like the substitution of a utilitarian grade of paper for their own stationery, which often constitutes part of their advertising format. A more serious problem is the possibility of having one's mail read by a third party. Extensive sampling

COMPLETING THE PICTURE . . .

Nuclear Systems Economical, Portable Radiography Machines



MODEL 52 MULTITRON . . . handling several sources for varying requirements.

"We save approximately 50% of radiography costs on welding inspection by using Nuclear Systems Equipment," said the Manager of Manufacturing at the Chattanooga, Tennessee plant of Combustion Engineering, Inc., last year when Nuclear Systems gamma radiography machines were in use many hours a day. *Now* these machines are used around the clock—and savings over the use of conventional X-ray equipment have increased proportionately. Without expensive rigging, high quality radiographs are being obtained wherever and whenever needed—on almost all sizes and shapes of welded vessels and components.

There's a Nuclear Systems radiography machine which can tighten up your quality control . . . ease up your budget. For full information, write any of our sales offices.

PHILADELPHIA • CHICAGO • SAN FRANCISCO

NUCLEAR SYSTEMS

A DIVISION OF THE BUDD COMPANY, Philadelphia 32, Pa.

IN CANADA—TATNALL MEASURING AND NUCLEAR SYSTEMS, LTD.
46 HOLLINGER RD. • TORONTO 16, ONT.

Budd

of the public's reaction to these matters would have to be made before a program of this kind would be started.

The incoming letter would be opened automatically and placed on a flat plate under a flying-spot scanner. This is a form of cathode ray tube in which the moving spot on the phosphor screen is projected optically onto the page to be scanned, and the reflected light is picked up by a phototube, whose output is the electrical signal. The beam is caused to scan along the width of the page by a local horizontal deflection circuit. Upon completion of this line, the beam is deflected back to start scanning the next line, which is $^1/_{100}$ of an inch below the previous line. This continues until the entire page is scanned, whereupon the beam returns to the starting position.

At the receiving end, the electrical signals must be converted back into hard copy. For this, the "Electrofax" process is used (see RCA Review, December 1954). A paper with a special coating is electrostatically charged and then exposed to the light beam from a cathode ray tube. This coating doesn't attain photographic sensitivity until an electrical charge is applied. It may be handled or stored in ordinary light until needed. The charge is placed on the paper when it is put into the machine for recording the incoming signal. The charge is reduced on the exposed areas in proportion to the amount of light received. This latent image is made visible by passing the paper through a tribo-electrically charged dry powder which clings to areas oppositely charged. The image is fixed by heating it for a few seconds, causing the plastic powder particles to fuse to the coated surface.

To get fast printing with a cathode ray tube, a tube with a very thin window—3 to 5 thousandths of an inch thick—may be used. This permits contact rather than projection printing from the face of the tube. Experiments have been made with a cathode ray tube with a mica window 8 in. wide, about $^1/_6$ in. high, and $2^1/_2$ mils thick. Horizontal movement of the beam is provided by a deflection circuit operated by the incoming synchronizing pulses, while motion of the paper past the tube gives vertical scanning.

Best Compromise

At present, the best compromise between high-speed printing, with its requirement for rapid start, and equipment complexity, as in storage units, seems to be the use of a frequency-division multiplex transmission storage combined with a scanning and printing speed of 2.5 sec per page. This corresponds to a paper speed of about 5 ips. A machine of this type can readily come up to speed in a few tens of milliseconds.

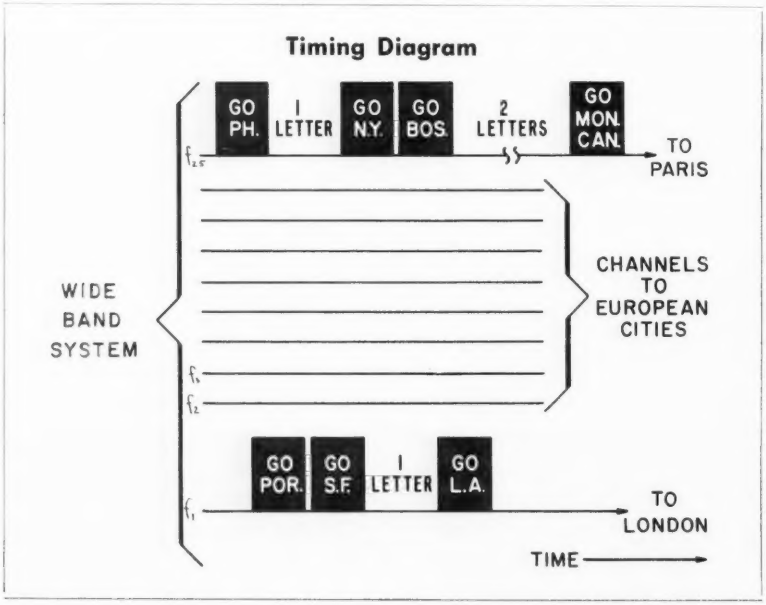
As shown diagrammatically on page 39, the Oribital Post Office ties together 25 major post offices on each continent. This network would consist of two parallel paths, one for each direction of transmission and each having a 5-mc bandwidth. The 5-mc band would be frequency-divided into 25 channels of 200 kc width, one for each of the major post offices. This is equivalent to providing 25 parallel but separate channels for each direction of transmission, each channel carrying traffic destined for only one major post office in the opposite continent. Actually, the post offices of the larger cities might have several channels assigned to them, while some of the smaller cities might share the same channel.

To prevent signals from several originating post offices from occupying the same channel at the same time, the post offices would use the common sending circuit serially. If a letter at a given station, say New York, was destined for say Paris, the scanner circuits would monitor the outgoing channel carrying Paris traffic. When the post office assigned to precede New York had completed its transmissions to Paris, it would signal New York to proceed. When New York had finished sending, or if it had nothing to send, it would signal the next post office in order to proceed. A "Timing Diagram" for this system is shown at bottom left. The command from one post office to the next on any one channel would be completely independent of the timing of these commands on the other channels.

For printing letters received via the satellite link, the recorder at each post office need only monitor the channel, or channels, allocated to it. Each incoming letter would be preceded by a start signal followed by the number of the designated major post office, the body of the letter, an "end of letter" signal, and an "end of series, next station transmit" signal. It would take 2.5 sec to send a letter on any channel, but the procedural signals would take only 0.5 millisec. Thus, if no post office should have letters destined for say Zurich, at one time, it would take about 50 millisec for each station to so state, commanding the next station to transmit, etc. and to return to the start, including transmission time through the 8000-mile circuit.

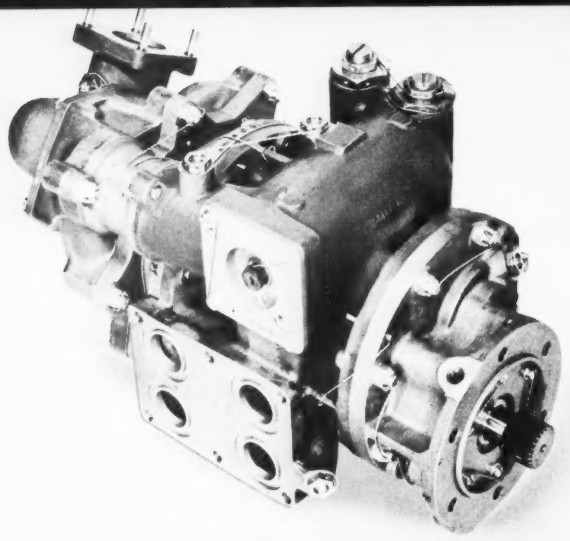
The major delays in transmission of a typical letter would include the time needed for delivery by truck and train from the local drop to the nearest major post office, and the reverse procedure at the other end.

As mentioned, a question yet to be answered is the public's feeling about a standard letter form and possibly losing some privacy to get this fast service. Otherwise, the preliminary RCA studies reveal no technical roadblock to the Orbital Post Office's transoceanic mail service.

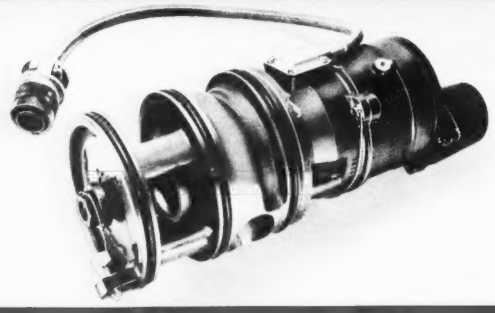


Based on a paper presented at the ARS 13th Annual Meeting and Astronautical Exposition held in New York, Nov. 17–21, 1958.

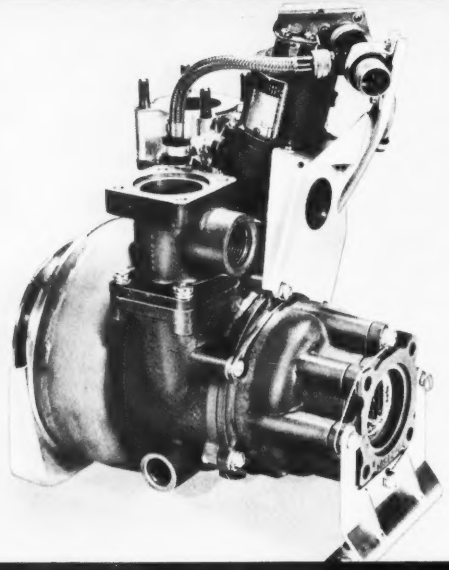
AT THE
TAPCO GROUP...
Development
and production of fuel
systems and components



TAPCO designed and produced engine-driven combination main-and-afterburner fuel pump now providing thousands of hours of trouble-free service in several current models of production fighter aircraft.



Plug-in type electric motor driven submerged booster pump, designed and produced by TAPCO for a major American jet airliner, facilitates easy removal for routine inspection without draining fuel tanks.



This turbine-driven water injection thrust-augmentation pump and controls combines three TAPCO Group capabilities: the experience and facilities to design, produce, and test the pump, electronic controls and turbine entirely within the TAPCO organization.

FROM THE TAPCO GROUP...

Pumps, Controls, and Accessories to handle any fuel, any fuel situation

Over 1,100,000 pumps delivered... twenty years of experience that began in 1939... 10,000 people... 3,000,000 square feet of research and production area... these are some of the reasons the TAPCO Group is the leading developer and manufacturer of all types of aircraft and missile pumps, controls, fuel valves, and turbine-driven pumps and accessories.

TAPCO pumps have been developed to meet severest conditions of altitude, rate of climb, pressure, attitude, G-factors, and fuel chemistry. TAPCO-designed models include vane- and gear-type main engine fuel pumps, fuel transfer and vapor separating booster pumps, thrust-augmentation pumps, turbo-pumps, combination main-and-afterburner pumps.

New TAPCO impeller designs, improved seals and internal passages give TAPCO pumps maximum efficiency and the ability to perform dependably under severest flight and temperature conditions, while pumping any of the approved liquid fuels and supplements. A feature of TAPCO booster pumps is high vapor-elimination capability, which eliminates vapor-lock in the fuel system.

Other fuel-system components and accessories developed in producing homogeneous, single-source TAPCO fuel systems include control valves, air turbine drives for pumps, quick-disconnect couplings, flow-equalizer valves, and in-flight refueling systems.

For your aircraft or missile contract, let us supply you with a *complete fuel system* designed, built, and fully service-tested by the leader and largest manufacturer of fuel pumps and systems... the TAPCO Group.

TRW

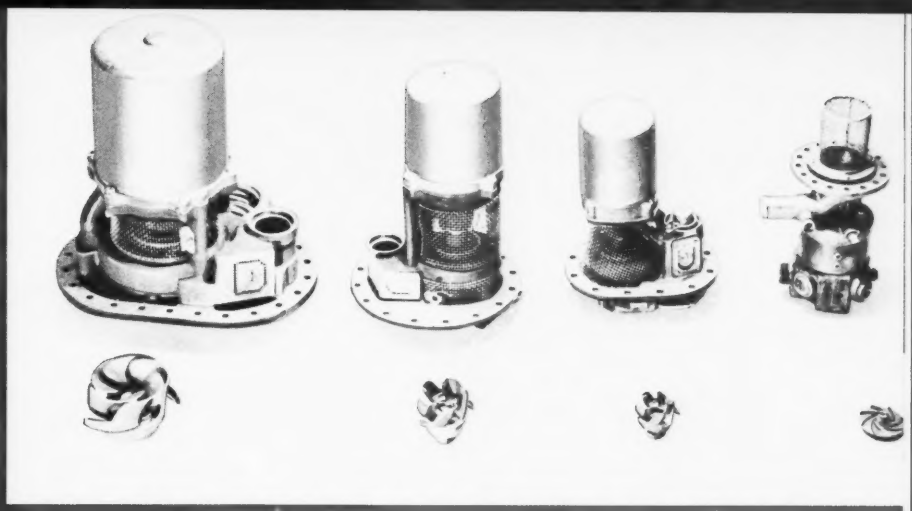
TAPCO GROUP

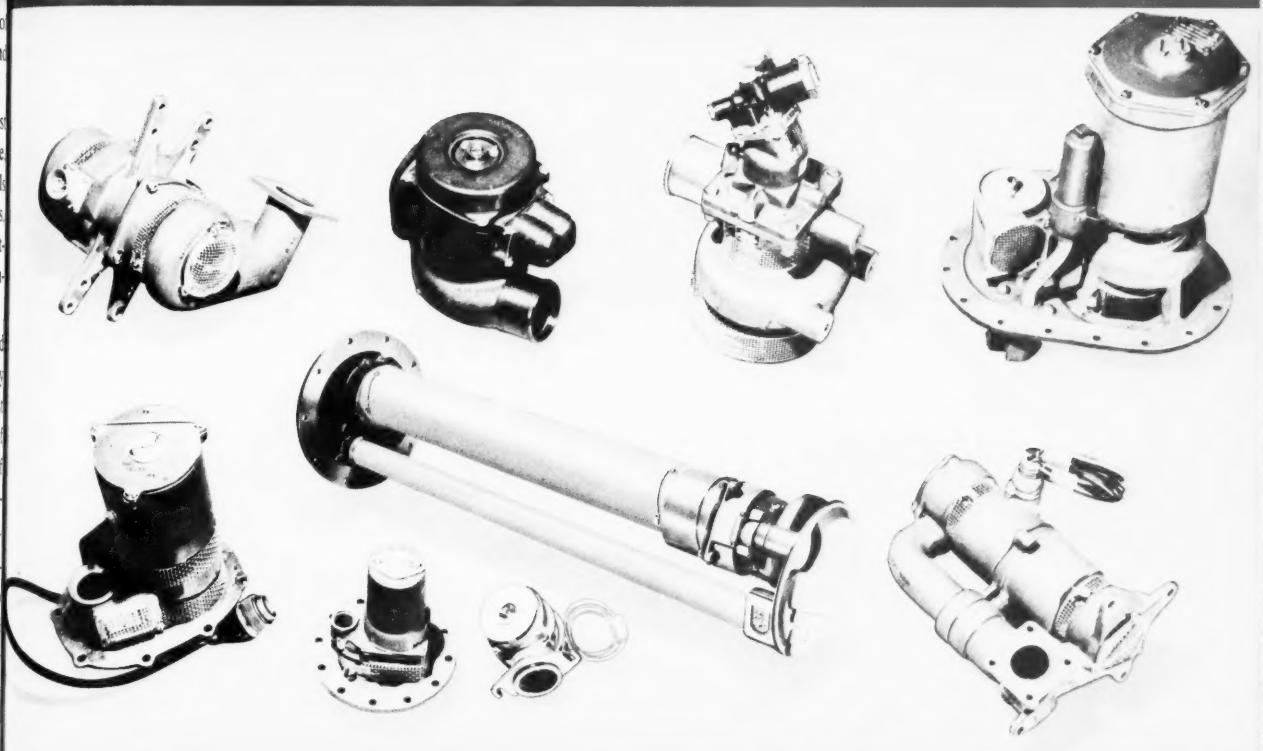
Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

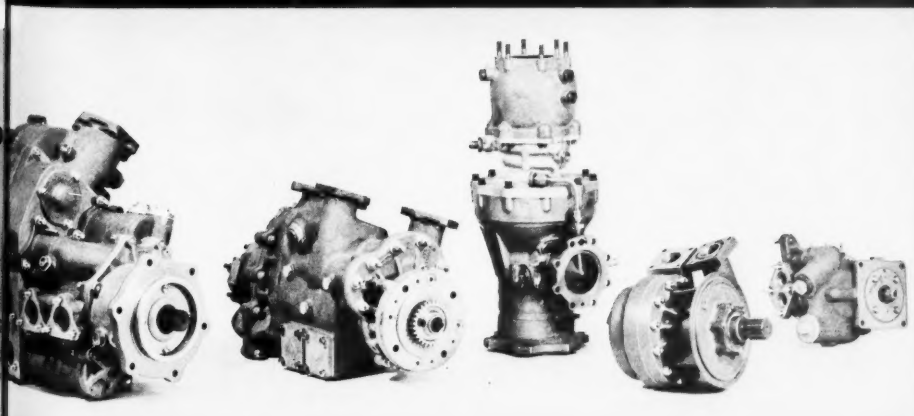
DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

20 years of booster pump experi- is illustrated by representative in this and the center photo. World War II DC electric motor- model, at right, had a capacity gpm at altitudes to 35,000 feet. models, at left and below, can up to 250 gpm at 70,000 feet. impellers shown indicate the results TAPCO research to provide good elimination and pumping ability requirements increased.





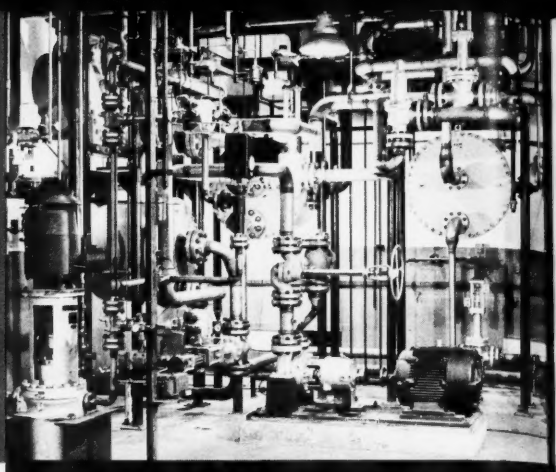
The broad variety of booster pumps now in production at TAPCO includes these AC electric and hydraulic motor-driven units for helicopters and small aircraft, as well as special designs for unusual negative G conditions for high performance fighter aircraft. Capacities range from 2 gpm to 250 gpm.



Engine-driven gear, centrifugal and regenerative-type fuel and water injection pumps for military and commercial aircraft are designed, produced and tested in the TAPCO Group's facilities. Capacities range from 2 gpm to 220 gpm, with discharge pressures as high as 1200 psi and suction specific speeds as high as 30,000 rpm.

IN THE TAPCO GROUP...

Complete research and test facilities... plus supporting services



Hot-fuel test lab at TAPCO, shown only in part here, can te fuel pumps under ambient temperature conditions as high a 750°F, circulating up to 500 gpm of fuel at 550°F at 1500 ps Pump-driver speeds up to 28,000 rpm are available. These con ditions can be cycled for high Mach number flight schedules

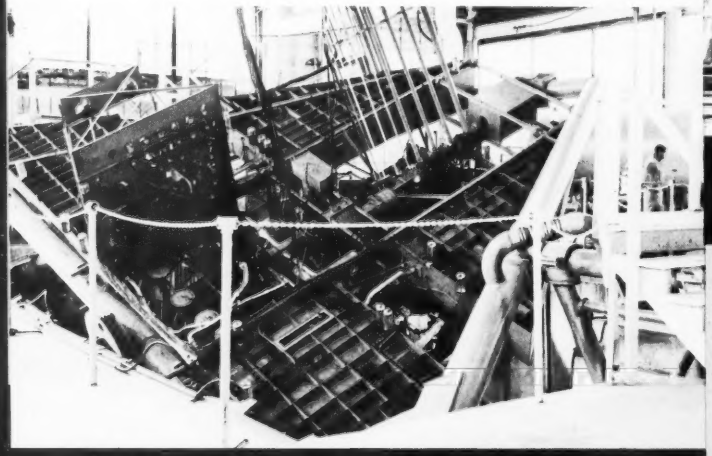
For over 20 years, the development of new fuel system principles and the design of pumps and components to utilize these principles have been a major area of investigation for the TAPCO Group research department. Just as the seemingly insurmountable problem of getting cargo aircraft over the Himalaya mountains was solved by TAPCO-pioneered booster pumps during World War II, TAPCO continues to pioneer the state of the art in fuel system development.

Today, more than 1000 experienced men and women using 7 TAPCO fuel labs are investigating and developing techniques to power tomorrow's flight vehicles of all types. They have worked with high energy fuels such as boron, slurries and monopropellant fuels such as ethylene oxide, UDMH and normal propylnitrate. Extensive work has been done with anhydrous hydrazine. Experience is being accumulated with the new fuels for advanced spacecraft, such as liquid hydrogen.

To assure proper support for fuel system and component contracts, a highly-skilled field service organization is maintained, and spare parts singly or in kits are available to meet your requirements.

Let us have a TAPCO Group sales engineer discuss *complete* fuel systems, pumps, controls, and valves with you soon.

Complete missile fuel system mockup at a TAPCO laboratory simulates missile flight conditions for pre-flight checkout of the fuel system.



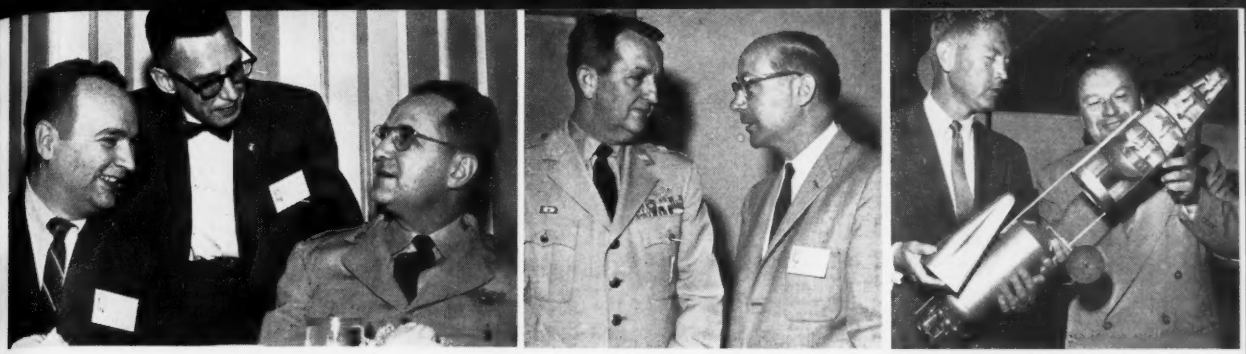
High performance fighter aircraft fuel system simulated by this complete mockup at another TAPCO facility saved hundreds of expensive flight test hours.

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES



Meeting speakers included ARS President John P. Stapp (photo at left) chatting with Gene Konecci of Douglas and William Radcliffe of Convair-Astronautics (in center); Maj. Gen. David Wade, USAF, Commander of the First Ballistic Missile Div., (center photo) talking with Ludwig Roth of Solar Aircraft; and James R. Dempsey of Convair (photo at right) looking over model of Outpost Satellite with Krafft Ehricke (right).

Semi-annual meeting grows in scope

THE INCREASED scope of the ARS Semi-Annual Meeting, which this year featured over 25 sessions in triple-feature halfday sessions, attracted an increased attendance totaling 3276 people. This total included 1826 technical registrants, of whom over 300 went on field trips, 750 exhibitor personnel who manned the 57 booths at the very successful ARS Astronautical Exposition, and 700 visitors to the exhibits. More than 45 ladies participated in the tours and social functions of the Ladies Program.

The meeting was held in the El Cortez Hotel in San Diego, June 8–11, with special field trips on June 12. Many of the 25 technical sessions were the first public program of some of the new technical committees. The sessions were amply attended, and only a few were uncomfortably crowded.

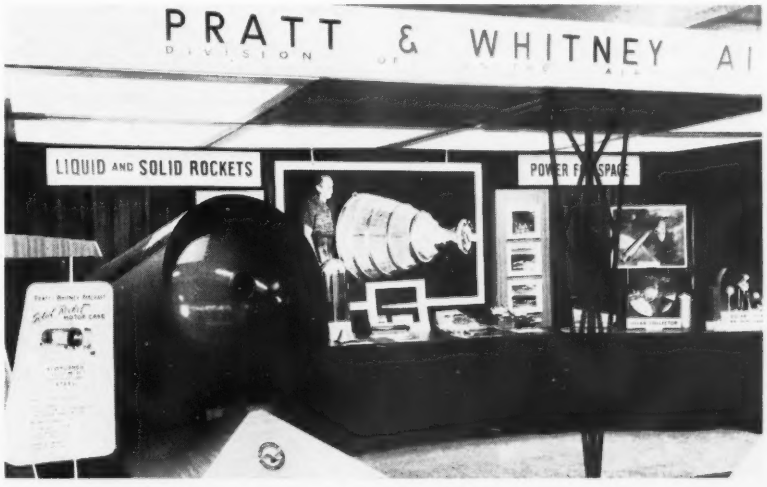
Top Speakers Featured

The Meeting Committee, under the leadership of John E. Naugle of the Convair Scientific Research Laboratory, was fortunate in obtaining an excellent group of speakers for the banquet and the four luncheons.

There can be no question that the historic highlight of the Semi-Annual Meeting was the banquet speech by Nobel Laureate Harold C. Urey. The title of Professor Urey's lecture was "Meteorites and the Moon," a scholarly review of the knowledge and understanding of the universe which earth-bound man has made to date with small budgets and a cloudy view through the earth's atmosphere. This review served as a subtle but formidable challenge to modern "spaceman," with his large budgets and unclouded view of the universe, to contribute a correspondingly vast amount to man's knowledge.

Professor Urey ranged over the known data on the structure of meteorites and their ages. Using this information to construct a model for the origin of meteorites, he concluded that two sets of objects are required to account for the properties of meteorites. These are "primary objects" of lunar size and "secondary objects," which are surface regions of the primary objects.

ARS President John P. Stapp spoke on "Man's Mission in Space" at the Monday banquet luncheon. "Man must either explore the extraterrestrial universe by every means he can develop or thereafter be a defector to the consistency of the scientific method, resigned to willful ignorance and no better than a speculative phi-



The Astronautical Exposition offered striking displays of new systems, processes, components, and planning for tomorrow's space projects. Above, Pratt and Whitney's booth; below, Marquardt emphasis on materials.

Martin-Denver showed this interesting model of a lunar housing simulator as part of its exhibit.

losopher," were the words used by Col. Stapp to define man's mission in space.

Maj. Gen. David Wade, Commander of the First Ballistic Missile Div., was the featured speaker at the Tuesday luncheon. His talk, entitled "Preparing for the Improbable," brought the meeting back from the realms of spaceflight to the harsher present-day reality of the problems of developing and maintaining the necessary military posture for the "improbable" event of a nuclear war. That is, one prepares for an event which if your preparations are adequate will not occur.

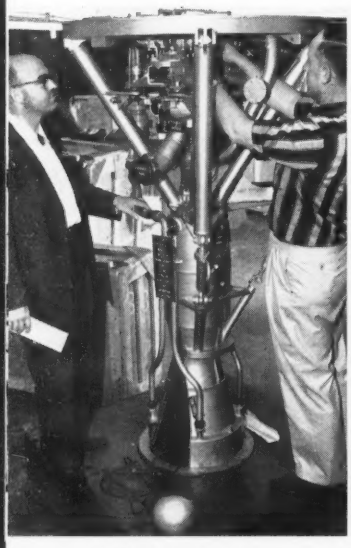
James R. Dempsey, a National Director of ARS and Manager of Convair-Astronautics, spoke on "Project Centaur—A Space Laboratory." He also described a proposed Project Outpost for establishing manned space units for 4 to 10 men (see page 20).

Abe Silverstein, Director of the Spaceflight Development for NASA, discussed a number of the problems involved in our national space program. The most important of these is reliability. Present-day rocket equipment is designed for 6 min of reliable operation. For the future, equipment which will operate reliably for a year or more must be developed, he said.

The fifth and final day of the meeting featured two classified field trips provided by the U.S. Navy. Nearly 130 persons were taken by the cruiser-tender USS Hector to San Clemente Island, some 70 miles off the coast, to witness a simulated rough-sea launching of a Polaris missile. The members and guests were given additional information in lectures and movies during the trips to and from the island. The second trip, a cruise on the missile ship USS Norton Sound, was attended by 125 persons. The ship, and its facilities and equipment, were inspected during a trip out to sea for a firing of a Terrier missile.

This meeting was a really outstanding success, owing to the unstinting efforts of a great many persons. Brooks Morris, ARS National Program Committee chairman, coordinated the technical session program. The local committee, the many San Diego section members, and their associates gave unstintingly of their time and effort to make essential contributions.

—John Naugle and Richard Linnell



Left, Meeting Committee chairman John Naugle of Convair Scientific Research Laboratory looks over GE display of Vanguard first-stage engine; center, Martin model of Dynasoar makes a bow; and (right) the growing importance of precisely engineered minor components reflects in Robertshaw display of pressure regulators.

A "TIME-TABLE" FOR SPACE CONQUEST

BY **1963** – INSTRUMENTED PLANETARY SOFT LANDING

BY **1968** – SPACE STATION FOR STAGING TO MOON AND PLANETS

BY **1970-75** – MOON BASE

These predictions were made by Alexander Kartveli, Vice-President for Research & Development at Republic Aviation, and one of the most optimistic of the 56 leading space experts of the world who were consulted by the U.S. House of Representatives Committee on Astronautics & Space Exploration for its report: "The Next 10 Years in Space, 1959-1969."

JOIN REPUBLIC IN AN **INTEGRATED ATTACK** ON PROBLEM AREAS OF **SPACE EXPLORATION**

It's the fervent conviction of engineers and scientists at Republic Aviation that the courageous "Space Time-Table" above is entirely feasible – given a tradition-free, integrated approach to the problems. Such an approach is evident at Republic Aviation. Here, groups of specialists from many disciplines are working in close collaboration to solve problems across the entire spectrum of space technologies, which limit today's interplanetary and upper atmosphere flight capabilities.

Expanded by $35,000,000 last year, Republic's integrated Research and Development program has already produced signal advances in space guidance concepts; in new propulsion systems (plasma, nuclear); in radiation physics; in new materials and processing techniques; in unique hypersonic configurations; and in prototype development of hardware (as an example: hydraulic systems that operate reliably up to 1000°F).

Professional men—who can meet new challenges with enthusiasm and dedication – are urged to look into openings with our R&D groups, working in an atmosphere of exhilarating intellectual adventure.

Electronics
Inertial Guidance & Navigation
Digital Computer Development
Systems Engineering
Information Theory
Telemetry-SSB Technique
Doppler Radar • Countermeasures
Radome & Antenna Design
Microwave Circuitry & Components
Receiver & Transmitter Design
Airborne Navigational Systems
Jamming & Anti-Jamming
Miniaturization — Transistorization
Ranging Systems
Propagation Studies
Ground Support Equipment

Thermo, Aerodynamics
Theoretical Gasdynamics
Hyper-Velocity Studies
Astronautics Precision Trajectories
Airplane/Missile Performance
Air Load and Aeroelasticity
Stability and Controls
Flutter & Vibration
Vehicle Dynamics & System Designs
High Altitude Atmosphere Physics
Re-entry Heat Transfer
Hydromagnetics
Ground Support Equipment

Plasma Propulsion
Plasma Physics
Gaseous Electronics
Hypersonics and Shock Phenomena
Hydromagnetics
Physical Chemistry
Combustion and Detonation
Instrumentation
High Power Pulse Electronics

Nuclear Propulsion and Radiation Phenomena
Nuclear Weapons Effects
Radiation Environment in Space
Nuclear Power & Propulsion Applications
Nuclear Radiation Laboratories

Send resume in complete confidence to: Mr. George R. Hickman, Engineering Employment Manager, Dept. 3H

REPUBLIC AVIATION

Farmingdale, Long Island, New York

ARS news

Gas Dynamics Symposium This Month

The Third Biennial Gas Dynamics Symposium, devoted to the Dynamics of Conducting Gases, will be held August 24–26 under the auspices of ARS and Northwestern Univ. at Northwestern's Technological Institute in Evanston, Ill. In 1955 the AMERICAN ROCKET SOCIETY and Northwestern Univ. initiated this series of biennial symposia to deal with recent and specialized fundamental aspects of jet propulsion. The first symposium had as its theme the subject of Aerothermochemistry. The second symposium held in 1957 dealt with Transport Properties in Gases.

Among the topics to be discussed at the 1959 Symposium are plasma physics, magnetogasdynamics, and power generation. The present state of the art will be considered with particular reference to the astronautical sciences, and promising avenues of research and development work will be suggested.

Symposium Sponsors

Air Force Office of Scientific Research
Army Office of Ordnance Research
National Aeronautics and Space Administration
Office of Naval Research (Project Squid)
Aerojet-General Corp.
Allied Chemical Corp.
Astrodyne, Inc.
Avco Corp.
Boeing Airplane Co.
Celanese Corp. of America
Chance-Vought Aircraft, Inc.
Douglas Aircraft Co., Inc.
General Dynamics Corp.
General Motors Corp.
International Harvester Co.
Linde Co. (Div. of Union Carbide Corp.)
Lockheed Aircraft Corp.
Marquardt Corp.
North American Aviation, Inc.
Northrop Corp.
Olin Mathieson Chemical Corp.
Phillips Petroleum Co.
Radio Corp. of America
Republic Aviation Corp.
Space Technology Laboratories, Inc.
The ADL Foundation of Arthur D. Little, Inc.
The Decker Corp.
The Pure Oil Co.
Thiokol Chemical Corp.
Thompson Ramo Wooldridge, Inc.
Westinghouse Electric Corp.

The papers to be presented are unclassified so that all registrants may participate actively in the discussions. Preprints will be available at the time of registration and it is planned to publish the papers and their pertinent discussions in a volume of proceedings.

The Symposium and the published volume of proceedings are dedicated to Theodore von Karman who has pioneered in this new field as he has in many others, and who will present the first paper in the program.

The full meeting program follows:

Monday, August 24

MAGNETO FLUID DYNAMICS AND PLASMA PHYSICS

9:00 a.m.

Chairman: Milton U. Clauser, Space Technology Laboratories, Los Angeles, Calif.
Welcome: J. Roscoe Miller, President, Northwestern Univ., Evanston, Ill.
Opening Remarks: John P. Stapp, President, AMERICAN ROCKET SOCIETY
✦Some Comments on Applications of Magneto-Fluid Dynamics, Theodore von Karman, Advisory Group of Aeronautical Research and Development, NATO, Paris, France. (891-59)
✦Electric Fields and Currents in a Highly Ionized Gas, William P. Allis, MIT, Cambridge, Mass. (892-59)
✦Some Properties of a Plasma, Robert A. Gross and C. L. Eisen, Fairchild Engine and Airplane Corp., Deer Park, N.Y. (893-59)

PLASMA PHYSICS

2:00 p,m.

Chairman: Eino K. Latvala, ARO, Inc., Tullahoma, Tenn.
✦Low Temperature Plasma Phenomena, R. J. Whalen and K. Pearce, Flight Sciences Laboratory, Inc., Buffalo, N.Y. (894-59)
✦Relaxation Processes in Plasmas, Hartwell F. Calcote, AeroChem Research Laboratores, Inc., Princeton, N.J. (895-59)
✦The Statistical Mechanics of the Approach to Equilibrium in Gases, I. Prigogine, Universite Libre de Bruxelles, Brussels, Belgium. (896-59)
✦Irreversible Processes in a Plasma: Effect of Long Range Forces, R. Balescu, Universite Libre de Bruxelles, Brussels, Belgium. (897-59)

Tuesday, August 25

MAGNETOGASDYNAMICS

9:00 a.m.

Chairman: Daniel Bershader, Lockheed Missiles and Space Div., Sunnyvale, Calif.
✦A Microscopic Analysis of Magnetogasdynamics, Eugene E. Covert, Naval Supersonic Laboratory, MIT, Cambridge, Mass. (898-59)
✦Some Solutions of the Macroscopic Equation of Magnetogasdynamics, W. R. Sears, Cornell Univ., Ithaca, N.Y. (899-59)
✦Magnetohydrodynamics in the Limit of Small Inertial Forces, Rudolf X. Meyer, Space Technology Laboratories, Los Angeles, Calif. (900-59)

MAGNETOGASDYNAMICS

2:00 p.m.

Chairman: Antoni K. Oppenheim, Univ. of California, Berkeley, Calif.
✦Axially Symmetric Hydromagnetic Channel Flow, F. D. Hains, Yusuf A. Yoler, and Edward Ehlers, Boeing Scientific Research Laboratories, Seattle, Wash. (901-59)
✦Magnetic Nozzles, Morton Rudin, Lockheed Missiles and Space Div., Sunnyvale, Calif. (902-59)
✦Applied Magnetohydrodynamics at Avco-Everett Research Laboratory, M. Camac and G. S. James, Avco-Everett Research Laboratory, Everett Mass. (902-59)
✦Considerations in the Design of a Steady DC Plasma Accelerator, G. P. Wood, NASA, Langley Research Center, Langley Field, Va. (903-59)

SYMPOSIUM BANQUET

7:00 p.m.

Toastmaster: James J. Harford, Executive Secretary, AMERICAN ROCKET SOCIETY.
Speaker: Sir Hugh Taylor, President, Woodrow Wilson National Fellowship Foundation and Dean Emeritus, Princeton Univ., Graduate School.

Wednesday, August 26

PLASMA PHENOMENOLOGY

9:00 a.m.

Chairman: Donald H. Loughridge, General Motors Corp., Detroit, Mich.
✦Plasmoids, W. H. Bostick, Stevens Institute of Technology, Hoboken, N.J. (904-59)
✦Techniques for Producing Plasma Jets, James A. Browning, Thermal Dynamics Corp., Hanover, N.H. (905-59)
✦Electromagnetic Shock Tubes, Richard W. Ziemer, Space Technology Laboratories, Los Angeles, Calif. (906-59)

PLASMA APPLICATIONS

2:00 p.m.

Chairman: John B. Fenn, Project Squid, Princeton Univ., Princeton, N.J.
✦Optimum Power Generation Using a Plasma as the Working Fluid, J. L. Neuringer, Scientific Research Staff, Republic Aviation Corp., Farmingdale, N.Y. (907-59)
✦Space Propulsion Engines—A Problem in Production of High Velocity Gases, Mark L. Ghai, General Electric Co., Evendale, Ohio. (908-59)
✦The Electromagnetic Pinch Effect Applied to a Space Propulsion System, Alfred E. Kunen, Scientific Research Staff, Republic Aviation Corp., Farmingdale, N.Y. (908-59)
✦Plasma Acceleration by Guided Microwaves, R. V. Hess, NASA, Washington, D.C. (909-59)

A UNIQUE APPROACH TO INFRARED GUIDANCE

This precision spherometer measures a unique material developed at Hughes for infrared guidance. It can measure the curvature of the dome's surface to an accuracy of 10^{-6} meters.

The material tested is unique in that it is completely opaque in the visible region, yet transmits very well in the infrared. First application of this material to military equipment requirements was carried out at Hughes.

This project is just one of the advanced studies in all phases of radar, inertial and infrared guidance currently underway at Hughes Research & Development Laboratories.

Assignments in missile guidance now open include:

Physicists to conduct Radiation Detector Studies
E.E.'s for Experimental Circuit Design
E.E.'s for IR Systems Studies
E.E.'s for Servo Analysis and Simulation
Optical Designers

The salary structure for the above positions reflects the advanced nature of the assignments. Please inquire by writing directly to: Dr. Allen Puckett, Director, Hughes Systems Development Laboratories.

the West's leader in advanced electronics

HUGHES

Hughes Aircraft Company, Culver City 61, California

©1959, H.A.C.

Photo Highlights of "Best Ever" Annual Telemetering Conference

Banquet at the 10th Annual National Telemetering Conference, jointly sponsored by ARS, AIEE, IAS, and ISA, with ARS host this year, featured cheerful miens as well as serious talk.

Banquet speaker Maj. Gen. O. J. Ritland, recently appointed head of BMD, is flanked on his left by W. J. Mayo Wells of NBS, who was instrumental in organizing the first annual telemetering conference and this year received the first Telemetering Conference Annual Award, and on his right by Max Lowy of Data Control Systems, Inc., chairman of the ARS technical committee on communications and chairman for the conference.

Stepping up to register. . .

. . .and off for a field trip

Twelve Receive Guggenheim Fellowships for 1959-60

Daniel and Florence Guggenheim fellowships, with stipends from $1200 to $2000 annually plus tuition, have been awarded twelve engineering students for graduate work in propulsion, structures, and spaceflight sciences during 1959–60.

Four new Fellows were appointed for graduate study at Princeton Univ.: Albert R. George Jr., Carle Place, Long Island, N.Y.; William A. Sirignano, New Rochelle, N.Y.; Paul Allen Taub, Brooklyn, N.Y.; and R. H. Woodward Waesche, Rockville Center, N.Y.

Three new Fellows were appointed at California Institute of Technology, and one 1958–59 Fellowship was renewed for the next academic season. The three new Fellows are Robert Goldstein, S. Ozone Park, N. Y.; Jason G. Seubold, Freeport, Ill., and Karl Louis Meier, St. Louis, Mo. Reappointed as a Fellow for the coming year was Frank A. Albini, Madera, Calif.

Four Fellows were appointed for study at Columbia: David L. Sikarskie, Petoskey, Mich.; Sheldon B. Cousin, Far Rockaway, N.Y.; David Feit, New York, N.Y.; and Rene B. Testa, Montreal, Canada.

Two More Companies Become ARS Members

Two more companies have become corporate members of the American Rocket Society. The companies, their areas of activity, and those named to represent them in Society activities are:

Celanese Corporation of America, New York, N. Y., engaged in solid and liquid propellants, missile chemicals, missiles, rockets and space vehicles, and structures and materials. Named to represent the company in ARS are J. P. Zeigler, manager, High Energy Materials Operations; J. H. Worth, assistant general manager, Chemical Div.; A. Schrage, development engineer; and F. G. Whitford, process design engineer.

Hallamore Electronics Co., A Division of the Siegler Corp., Anaheim, Calif. Representing the company in ARS are Lloyd G. Hallamore, president; John J. Burke, executive vice-president; F. W. Lynch, vice-president, engineering; W. F. Sampson, director, Space Communications Lab; and W. Q. Nicholson, director, Airborne Systems.

Bound Volumes Available of Telemetering Proceedings

A limited quantity of bound proceedings of the 1959 National Telemetering Conference (AIEE-ISA-ARS-IAS) are available at $6.50 per copy. Please send your order to the ARS National office, 500 Fifth Avenue, New York 36, N. Y.

Reeves INSTRUMENT CORPORATION

is part of the picture on front page projects of today.

A HIGHLIGHT ON CREATIVE SYSTEMS ENGINEERING AT Reeves

PRECISION...ON A SPACE-HIGH PEDESTAL

Reeves has pioneered in the development of extremely high precision two- and three-axis antenna pedestals for fire control, guidance and tracking systems. Reeves-engineered pedestals and related electronic assemblies, including servo systems and computers, are production-ready in types for both land-based and shipboard applications. The pedestals provide continuous rotation in azimuth, with angular travel in the remaining two axes designed to meet particular requirements. Accuracies in the order of 0.1 milliradians can be achieved, with rates of 10 degrees per second, or higher.

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

Roosevelt Field, Garden City, New York

Qualified engineers who are seeking rewarding opportunities for their talents in this and related fields are invited to get in touch with us.

Front page projects of tomorrow are part of the picture at Reeves INSTRUMENT CORPORATION

6RV59

SECTIONS

Central California: A dinner-dance meeting was held in April at the Montecito Country Club. The meeting proper featured a talk on missile guidance by **R. A. Sinker** of Hughes Aircraft Co.; a satellite exhibit prepared by members of the Pacific Missile Range; and the election of new officers, who are as follows: Gen. Winston W. Kratz, president; Comdr. Robert F. Frietag, USN, vice-president; Donald L. Baker, secretary; and William H. Evans, treasurer. This was an enjoyable and lively meeting, and the members are looking forward to more like it in the coming year.

—**D. L. Baker**

Chicago: May saw the annual Ladies Night meeting, which featured **Carl Sagan** of Yerkes Observatory talking on "Astronomy and Spaceflight." Dr. Sagan reviewed the solar system and then focused on Mars. During the subsequent question and answer session, the satellite to test the general theory of relativity was discussed.

Finally S. J. Fraenkel, retiring president, handed over the gavel to incoming president C. C. Miesse. Other officers for the coming year are Joseph Elward, vice-president; Ben Harrison, treasurer; and A. E. Fuhs, secretary.

—**R. C. Warder Jr.**

Connecticut Valley: On May 12 some 60 members and guests of the Connecticut Valley section were guests of the Chandler-Evans Corp., West Hartford, Conn., for a dinner meeting and plant tour. James Harford, ARS executive secretary, also attended. Following the business meeting, the members and guests were conducted on a tour of the engineering, experimental, and production facilities of Chandler-Evans. A highlight of the tour was a visit to the new Thermo-Research Center, in which fuel-system components for aircraft and missile applications are tested at the high temperatures associated with supersonic flight speeds. This was one of the most interesting activities in the history of the Section.

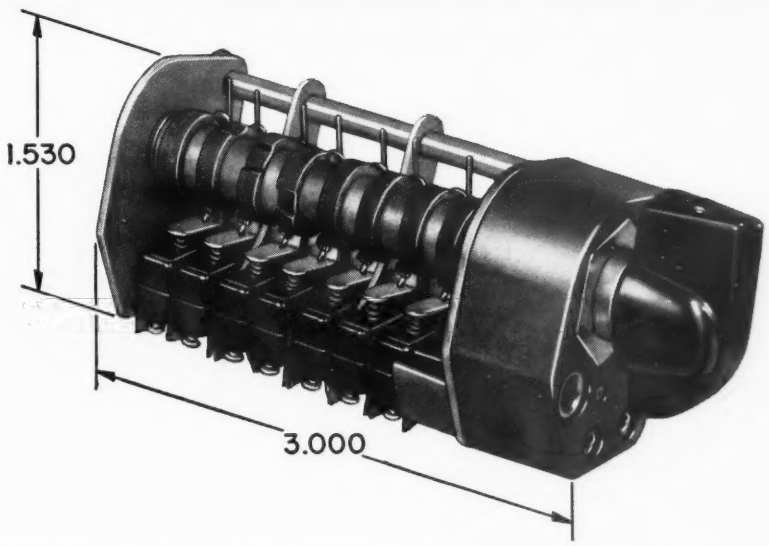
On the calendar

1959	
Aug. 9–12	ASME-AICE Heat Transfer Conference, Univ. of Connecticut, Storrs, Conn.
Aug. 18–21	1959 Western Electronic Show and Convention, San Francisco.
Aug. 24–26	**ARS Gas Dynamics Symposium, Dynamics of Conducting Fluids, Northwestern Univ., Evanston, Ill.**
Aug. 27–29	American Physical Society 1959 Summer Meeting in the West, Univ. of Hawaii, Honolulu.
Aug. 28–29	British Commonwealth Space Flight Symposium, Westminster, London.
Aug. 31-Sept. 2	4th Int'l Symposium on Free Radical Stabilization, sponsored by National Bureau of Standards, at Dunbarton College Auditorium, Washington, D. C.
Aug. 31–Sept. 5	**10th Annual International Astronautical Federation Congress, Westminster, London.**
Sept. 1–2	Physical Chemistry in Aerodynamic Spaceflight Conference, jointly sponsored by AFOSR and GE MSVD, at Univ. of Pennslyvania, Philadelphia.
Sept. 2–4	1959 Cryogenic Engineering Conference, Univ. of California, Berkeley, Calif.
Sept. 9–11	Midwestern Conference on Fluid and Solid Mechanics, Univ. of Texas, Austin.
Sept. 22–24	Industrial Nuclear Technology Conference, co-sponsored by Illinois Inst. of Tech., at Morrison Hotel, Chicago.
Sept. 28–Oct. 1	American Welding Society Fall Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.
Oct. 6–8	Radio Interference Reduction and Electronic Compatibility Conference sponsored by Army Signal R&D Labs at Illinois Institute of Technology, Chicago.
Oct. 6–9	Int'l Symposium on High Temperature Technology, sponsored by Stanford Research Institute, at Asilomar, Calif.
Oct. 7–9	ASME-AIME Solid Fuels Conference, Cincinnati, Ohio.
Oct. 7–9	1959 National Symposium on Vacuum Technology, American Vacuum Society, Sheraton Hotel, Philadelphia.
Oct. 12–14	National Electronics Conference, co-sponsored by Illinois Inst. of Tech., at Hotel Sherman, Chicago.
Oct. 13–14	National Technical Conference on "Plastics Engineering—State of the Art Today," sponsored by Society of Plastics Engineers at the Ambassador Hotel, Los Angeles.
Oct. 26–28	IRE Professional Group East Coast Conference on Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md.
Oct. 26–30	1959 National Conference of the Society of Photographic Scientists and Engineers, Edgewater Beach Hotel, Chicago.
Oct. 28–29	6th Annual Computer Applications Symposium, sponsored by Illinois Inst. of Tech., at Morrison Hotel, Chicago.
Nov. 5–6	8th Annual Instrumentation Conference sponsored by Louisiana Polytechnic Institute School of Engineering, Ruston, La.
Nov. 16–20	**ARS 14th Annual Meeting and Astronautical Exposition, Washington, D.C.**
Nov. 16–20	5th Int'l Automation Exposition and Congress, N.Y. Trade Show Bldg., New York, N.Y.
1960	
Jan. 11–13	6th National Symposium on Reliability and Quality Control in Electronics at Washington, D.C., sponsored by American Society for Quality Control, IRE, AIEE, and EIA.
Jan. 28–29	**ARS Solid Propellants Conference, Princeton Univ., Princeton, N.J.**
Feb. 1–5	ISA Instrument-Automation Conference and Exhibit, Houston Coliseum, Houston, Tex.

Chicago Section Officers

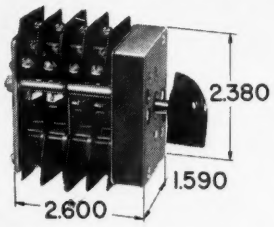
C. C. Miesse, seated right, is the Chicago section's new president; next to him, Ben Harrison, new treasurer; and standing, on left A. E. Fuhs, secretary, and on right Joseph Elward, vice-president.

MICRO SWITCH Precision Switches

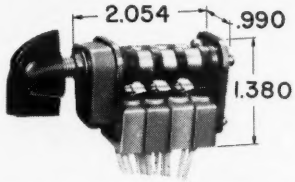


New rotary selector switch assemblies feature "cock-and-fire" actuation

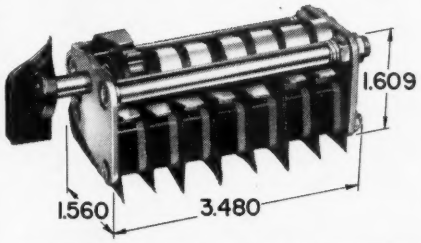
OTHER ROTARY ASSEMBLIES



"20AS" series double-row "V3" assembly (Knob not furnished)



"25AS" series sealed subminiature assembly (Knob not furnished)



"7AS" series single-row "V3" assembly (Knob not furnished)

The new "28AS" Series of rotary selector switch assemblies have a "cock-and-fire" actuating mechanism that moves positively from one position to another, imparts a good feel of the detent action and provides immediate indication of each position. Aircraft engineers have found these switches ideal for mounting in close-coupled designs. Features include:

Reliable Operation

Individual actuating levers pivot on a common rod, insuring maintained adjustment. The levers are operated by precision cams which are rigidly mounted on the actuator shaft. A seal ring on the shaft keeps out moisture. Panel seals are optional.

"Non-Tease" Circuitry

The actuating mechanism moves positively from one position to another. There is no possibility of circuit "tease" or actuator "hang-up" between the 90° detents.

Variety of Sequences

Up to seven basic switches and two or three actuator positions may be provided. Innumerable sequences can be factory-adjusted to fit specific circuit requirements.

Send for Data Sheet 162

For information of the "28AS" Series or other versatile MICRO SWITCH rotary switches, consult experienced engineers at your nearby branch—or write to:

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

St. Ambrose College Student Chapter Receives Charter

Stephen Fraenkel, third from right, president of the Chicago section, presents charter to representatives of new St. Ambrose College Student Chapter: From left, E. M. Vaughan, faculty adviser; George Heenan, interclub council representative; Duane M. Williams, treasurer; Nicholas Kass, president, accepting charter; Fraenkel; Michael O'Leary, vice-president; and William Lindquist, secretary.

A Rare Night, For the Ladies

Member's wives joined their husbands to make this convivial group at the Chicago section's annual Ladies Night Dinner.

ARS Paper Deadlines

Date	Meeting	Location	*Deadline
1959			
Aug. 24–26	Gas Dynamics Symposium	Northwestern Univ.	Past
Aug. 31–Sept. 5	10th IAF Congress	Westminster, London	Past
Nov. 16–20	14th Annual Meeting	Washington, D.C.	Aug. 17
1960			
Jan. 28–29	Solid Propellants Conference	Princeton Univ.	Nov. 16

* For reviewed and approved manuscripts in the New York office. Subtract 30 days for unsolicited papers that must go through the reviewing procedure and 60 days for abstracts submitted for consideration. Send all papers and abstracts to Meetings Manager, ARS, 500 Fifth Ave. New York 36, N.Y.

Holloman: The section held its June meeting at the Desert Aire Hotel in Alamogordo. President Millsaps opened the meeting with a short explanation of the scientific lecture series being conducted at Cloudcroft, N.M., by the Air Force Missile Development Center and the Univ. of New Mexico. He then introduced a delegation of guests from the Air Force Special Weapons Center, five Spanish officers attending special missile training with the Center, and the honored guest and evening speaker, **Theodore von Karman.**

Dr. von Karman talked primarily on the education of engineers and scientists. He pointed out that engineering education has been transmitting the last generation's knowledge to each succeeding generation and also that this engineering education has been characterized by largely empirical knowledge. He stated that empirical knowledge alone cannot possibly be sufficient; that we must teach not only how to calculate specific problems but must somehow teach understanding; that the engineer should have a real understanding of natural sciences but need not be, in the full definition of the word, a scientist; and that the engineer in sales and management has a further obligation—to understand the fundamentals of the social sciences.

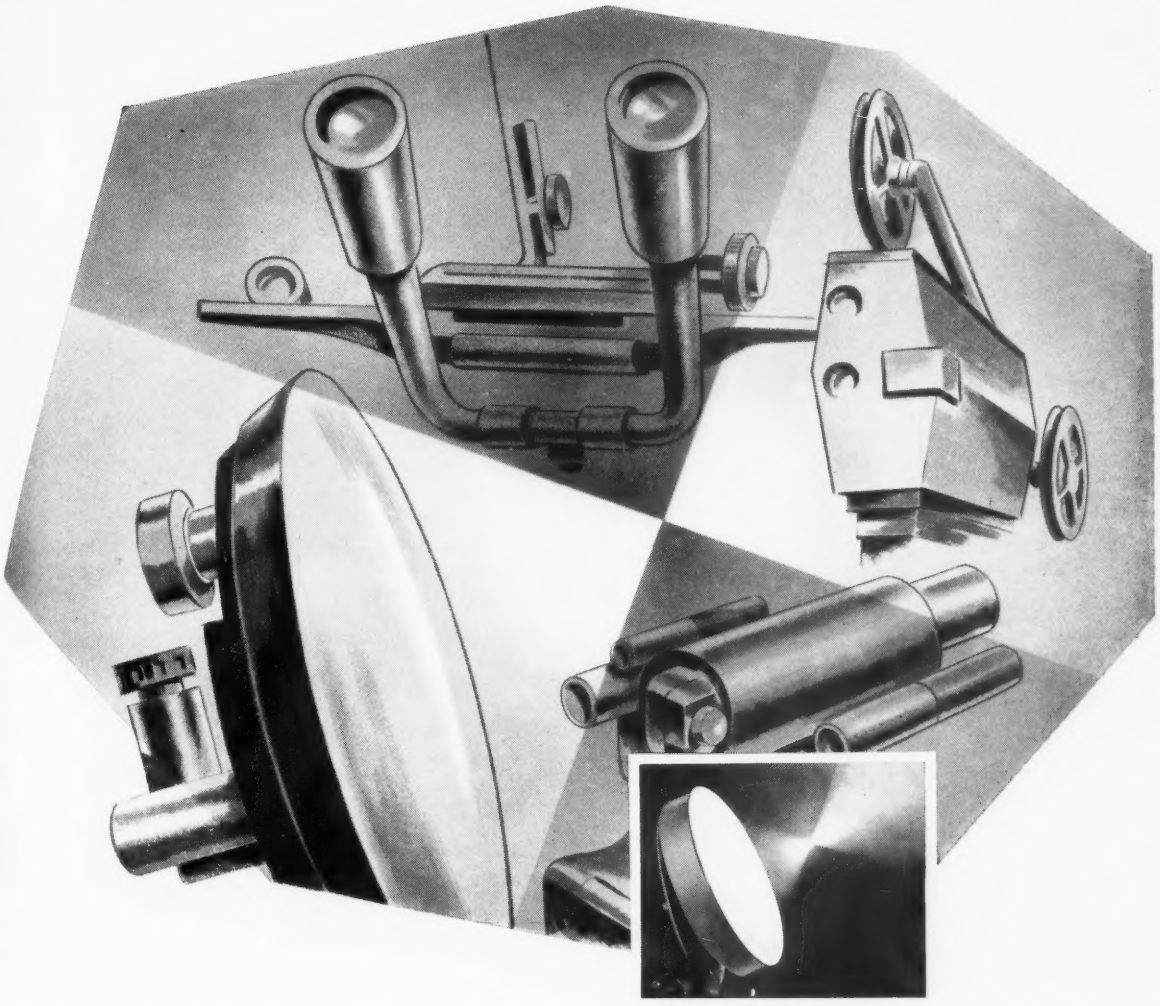
Cycles and the swinging of the pendulum from one extreme to another were cited by Dr. von Karman as a defect in modern education. He said that from time to time we have too great an emphasis on engineering for the purpose of designing or creating hardware and then the swinging of the pendulum in the opposite direction toward emphasis on theory. He called attention to the fact that the aeronautical engineer to be, in any sense of the word, a modern engineer must learn considerable physics, chemistry, and electrodynamics.

Dr. von Karman concluded his talk by very graciously expressing his pleasure in addressing the section.

—Harry L. Gephart, Lt. Col., USAF

Indiana: At the April meeting, **R. J. Priem,** head of the rocket-combustion section at NASA Lewis Research Center, presented a talk entitled "X-15—Giant Step into Space." He also showed a movie which dealt with aerodynamic heating in the flight of the X-15.

The activities for the academic school year reached a climax, as usual, with the Annual Spring Banquet in May, which was also the occasion of the Tenth Annual Banquet for the Indiana section. The speaker at the banquet was **Maj. Gen. H. N. Toftoy,** Commanding General of Aberdeen Proving Ground. During WW II,



Unbreakable Repli-Kote Mirrors out-perform glass, slash costs

These new lightweight, low distortion Repli-Kote Mirrors of cast epoxy resin offer design engineers optical reflectors with a matchless combination of properties, impossible with glass. A single master mirror is all that's necessary for mass producing precision Repli-Kote Mirrors—at significant cost savings.

Optical Precision — 6″—5¼″ Focal Length Repli-Kote paraboloid mirrors have been produced in quantity with an accuracy permitting 90% of incident collimated light to be concentrated within a disc of 0.1 mm diameter. Higher rate of thermal diffusion through epoxy also lowers distortion caused by temperature transients.

Permanent Reflective Surface — High vacuum applied, silicon monoxide protected aluminum reflective surface is *permanently* bonded to epoxy backing, will resist flaking or peeling for extended periods.

High Mechanical and Thermal Shock Resistance — Repli-Kote Mirrors have withstood impacts *as severe as 22,000 g*, undergone rapid temperature cycling from −55°C to +125°C with no measurable physical change.

Light Weight—Repli-Kote Mirrors cast of epoxy are much lighter than glass. Suitable fillers can be added if desirable.

Any Shape—Paraboloids, hyperboloids, ellipsoids and more complex aspheric surfaces not previously reproducible in glass by mass production methods can now be quickly fabricated.

Ease of Mounting—Fixtures, threaded inserts, electrical components can be molded directly into the mirror backing, opening an almost limitless field of design possibilities. Repli-Kote Mirrors are also easily machined.

If you are working on tracking and guidance systems—or any system employing reflective optics—durable, lightweight, precision Repli-Kote Mirrors offer you greater design and production freedom. Let us help you make the most of Repli-Kote Mirrors in building a better product at lower cost.

Address Inquiries *to Repli-Kote, Singer-Bridgeport, 915 Pembroke Street, Bridgeport 8, Conn.*

SINGER

MILITARY PRODUCTS DIVISION

THE SINGER MANUFACTURING COMPANY

Military Products Division • 149 Broadway, New York 6, N. Y.

HRB • DIEHL • BRIDGEPORT

1385

Chandler-Evans Hosts Connecticut Valley Section

After a dinner meeting as guests of Chandler-Evans, at its West Hartford, Conn., plant, members of the Connecticut Valley section toured the company's new Thermo-Research Center for testing missile components at high temperatures. Photo at left (from left) Harold E. Francis and A. M. Wright, chief project engineer and vice-president for engineering, respectively, for Chandler-Evans, explain control's of the Thermo-Research Center to James Harford, ARS executive secretary, a guest for the occasion, and to C. W. Lemmerman, Connecticut Valley section president; right, interior of high-temperature test cell of Center.

American Rocket Society

500 Fifth Avenue, New York 36, N. Y.

Founded 1930

OFFICERS

President	John P. Stapp
Vice-President	Howard S. Seifert
Executive Secretary	James J. Harford
Treasurer	Robert M. Lawrence
Secretary and Asst. Treasurer	A. C. Slade
General Counsel	Andrew G. Haley
Director of Publications	Irwin Hersey

BOARD OF DIRECTORS

(Terms expire on dates indicated)

James R. Dempsey	1961	Simon Ramo	1960
Alfred J. Eggers Jr.	1959	H. W. Ritchey	1959
Krafft Ehricke	1959	William L. Rogers	1959
Samuel K. Hoffman	1960	David G. Simons	1961
J. Preston Layton	1960	John L. Sloop	1961
A. K. Oppenheim	1961	Martin Summerfield	1959
William H. Pickering	1961	Wernher von Braun	1960
		Maurice J. Zucrow	1960

TECHNICAL COMMITTEE CHAIRMEN

Lawrence S. Brown, Guidance and Navigation
Milton U. Clauser, Hydromagnetics
Kurt H. Debus, Logistics and Operations
William H. Dorrance, Hypersonics
Herbert Friedman, Instrumentation and Control
George Gerard, Materials and Structures
Milton Greenberg, Physics of the Atmosphere and Space
Stanley V. Gunn, Nuclear Propulsion
Andrew G. Haley, Space Law and Sociology
Samuel Herrick, Flight Mechanics
Max Hunter, Missiles and Space Vehicles
David B. Langmuir, Ion and Plasma Propulsion
Y. C. Lee, Liquid Rockets
Max Lowy, Communications
Harold W. Norton, Test Facilities and Support Equipment
Paul E. Sandorff, Education
William Shippen, Ramjets
John L. Sloop, Propellants and Combustion
Ivan E. Tuhy, Solid Rockets
Stanley White, Human Factors and Bio-Astronautics
George F. Wislicenus, Underwater Propulsion
Abe Zarem, Non-Propulsive Power

Gen. Toftoy recommended bringing to this country and employing approximately 130 German missile experts. This operation. known as "Project Paperclip," was the subject of Gen. Toftoy's talk.

—**Jerome A. Camp**

Maryland: At a dinner meeting in June, held at the Westinghouse Air Arm Div. near Friendship Airport, guest speaker **Walter Dornberger,** engineering executive of Bell Aircraft and one-time chief of German rocket development, discussed our national space program.

The dinner meeting also saw the Maryland section's annual award for advancing the state of the art—a plaque and scroll – presented to Charles J. Giemza, engineering supervisor of metals research at Martin-Baltimore, for his work in the development of structurally sound beryllium sheet.

Northeastern New York: At the annual banquet, held in June in Schenectady, approximately 60 members and guests heard **Kurt Stehling** of the NASA Office of Program Planning and Evaluation discuss some of the more interesting national propulsion projects. Retiring president A. R. Graham then conducted a short business meeting and introduced the new officers for the coming year: N. E. Munch, president; R. K. Rose, vice-president; E. Fried, secretary; and J. W. Halliday, treasurer.

—**R. K. Rose**

HAVEG - FIRST IN *Engineered* PLASTICS®

HAVEG®

This newest American Bird screams through the sky with nose cones provided by Haveg Industries*

HAVEG INDUSTRIES, INC.

900 GREENBANK ROAD • WILMINGTON 8, DELAWARE

Reprints of the above illustration without advertising material and suitable for framing may be obtained by writing Haveg Industries, Wilmington, Delaware.

*Missile names will be supplied by Haveg Industries after proper clearance.

high-energy fuel briefs from Callery

Callery opens office in Los Angeles—Fuel and propellant users on the West Coast can now contact Dr. Robert G. Brault, Callery's Manager, Western District, for helpful technical service. He has opened an office at 3141 Century Boulevard, Inglewood, California. Telephone: ORegon 8-9382. Dr. Brault was formerly Research Coordinator of the Project Zip high-energy fuel program at Callery's R & D Laboratories.

Diborane as fuel for rockets, ramjets, and turbojets—With a heat of combustion of 31,300 Btu/lb. and extremely good combustion properties, Diborane is an attractive fuel for air-breathing engines. Diborane, a gas at standard conditions, can easily be liquefied (boiling point –134°F). With modern insulating methods, it should be storable for long periods. Its specific gravity at a temperature slightly above its melting point (–265°F) is 0.56, so that it contains more Btu/gallon than JP fuels. Diborane has excellent heat-sink capabilities.

Recent calculations, based on the most recent thermodynamic data, show Diborane-LOX to have an I_{sp} of 349 sec. (1000/14.7 psia, shifting equilibrium). With its higher density and boiling point, it may be superior to hydrogen for some applications. Diborane will soon be available in tonnage quantities. Write for Technical Bulletin C-020 for detailed information.

HiCal® fuel now available—Since Callery's production of HiCal, high-energy fuel, will exceed immediate military test-program requirements for the next few months, substantial quantities of HiCal-3 are now available for authorized users with suitable security clearance. If you have been waiting to test HiCal-3 in engines or components, write now for specific information. Our HiCal-3 Handling Bulletin C-1100 is available on request.

New specific-impulse calculations—Specific-impulse data for several combinations of boron-containing fuels with various oxidizers have recently been calculated and tabulated. Most of these data are confidential, but Callery representatives would be pleased to discuss them with you on a classified basis.

Fire-fighting films on HiCal and pyrophoric fuels—The HiCal film shows the relative ease and safety with which a stable mechanical-foam blanket can extinguish burning HiCal fuels. Another 15-minute film illustrates the techniques available for combating fires of Trialkyl Boranes.

For information or loan of films, write to Defense Products Dept., Callery Chemical Company, 9600 Perry Highway, Pittsburgh 37, Pa.

CALLERY
CALLERY CHEMICAL COMPANY
9600 PERRY HIGHWAY PITTSBURGH 37 PENNSYLVANIA

Dr. Robert G. Brault
Manager
Western District
Callery Chemical Company

Sacramento: At the May meeting, held at the McClellan AFB Officers Club, the section was host to ARS President **John P. Stapp.** A capacity audience heard Colonel Stapp describe his pioneering experiences in rocket-propelled sled tests. He also showed films of human centrifuge tests conducted under his supervision. Colonel Stapp emphasized that the results of tests simulating spaceflight conditions indicate that physically and psychologically man will encounter no insuperable obstacles on an orbital jaunt. The chief problem and toughest challenge facing American space scientists, in plans to put a man into orbit in 1961, he said, is not the trip up but the guarantee of a safe return.

Experiments with the centrifuge have provided data indicating that a web-type seat, conforming to the occupants shape under pressure, and having the body position with the knees up and the abdomen forming a 12-deg angle with the vertical, provides the best body configuration for withstanding the forces caused by the ascent. This configuration will be used when the Project Mercury astronaut rides into space, strapped in a capsule atop a three-stage rocket. During the first-stage flight, the astronaut will be subject to 8 g. This will drop to 6 g during the second stage, and 4 g during the third stage of the ascent, before the rocket finally reaches a speed of more than 18,000 mph and an orbital height of 150 to 200 miles. Each stage will last approximately $2^1/_2$ min.

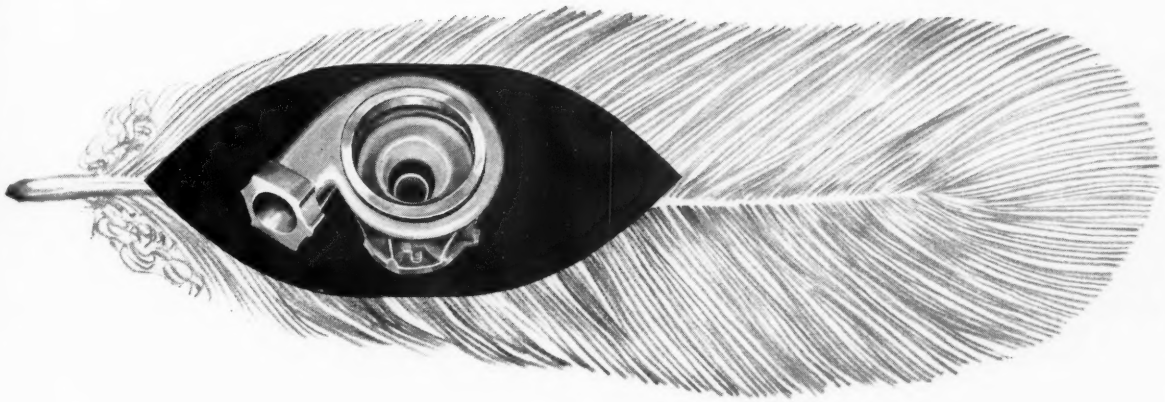
—Ira Nagin

St. Joseph Valley: Over 100 persons attended the joint meeting of the section and the Engineer's Club of St. Joseph Valley in April to hear **R. C. Baumann** of NASA's Vanguard Div. discuss "Manmade Satellites" and show films of launchings. This was an interesting and well-attended meeting.

—Marvin S. Ehrenberg

St. Louis: Pierre M. Honnell, professor of electrical engineering at Washington Univ., addressed the May meeting on the topic of "Auxiliary Power Sources for Space Vehicles." Dr. Honnell presented a survey of auxiliary power sources available to the designer today or in the very near future. In particular, he discussed the possibilities of obtaining sustained power in the 200-watt range for a period of about two years by such means as nuclear-energy devices, solar cells, electrochemical sources, fuel cells, and less often considered means, such as coal, springs, and compressed gases. Only the nuclear sources and solar cells, he said, seemed promising in the near future for the specified application.

new weight saving material for missiles and high performance jet aircraft



NEW HIGH-STRENGTH . . . HIGH-PURITY ALUMINUM CASTING ALLOY

If you've been pushing A-356 to the limit of its physicals to scrape off every possible ounce of excess weight . . . then new alloy MA-356 was made to order for you. With a few minor changes in chemical composition, Rolle has produced what is essentially a new casting material. Highly responsive to heat treatment, it permits higher tensile strength, higher yield strength, and greater elongation. Rolle is pouring MA-356 now . . . in castings that consistently exceed the physical requirements of MIL-C-21180A. Check, for example, the typical sand cast range of properties MA-356 permits in the T-6 condition against what you can expect from conventional A-356 at left:

ALLOY (T-6)	U.T.S. (psi)	Y.S. (psi)	E (%)
A-356	40,000	30,000	3
MA-356			
minimum	40,000	30,000	5
maximum	50,000	40,000	2

One of the advantages of MA-356 is that any desired physical within the typical range can be emphasized through careful control of heat treatment of the casting. Even more exciting are the extremely high physicals that have been achieved with MA-356 in favorable casting configurations. Test castings have actually exceeded a tensile strength of 54,000 psi and yield strength of 44,000 psi with 2% elongation.

But no two castings are alike. It's impossible to predict the benefits MA-356 will confer on your sand and permanent mold castings without prints and specs. If you'd like more information on this new alloy, write for Technical Data Bulletin 1001. And when you do, why not ask for your copy of our 58-page light metals casting handbook . . . an engineering guide to aluminum and magnesium sand and permanent mold castings. Rolle Manufacturing Company, 319 Cannon Avenue, Lansdale, Pennsylvania, or call ULysses 5-1174.

ROLLE

In conclusion, Dr. Honnell described the recent accomplishment of the U.S. in reflecting radio signals off the planet Venus and predicting correctly their distortion.

—Albert E. Cohen

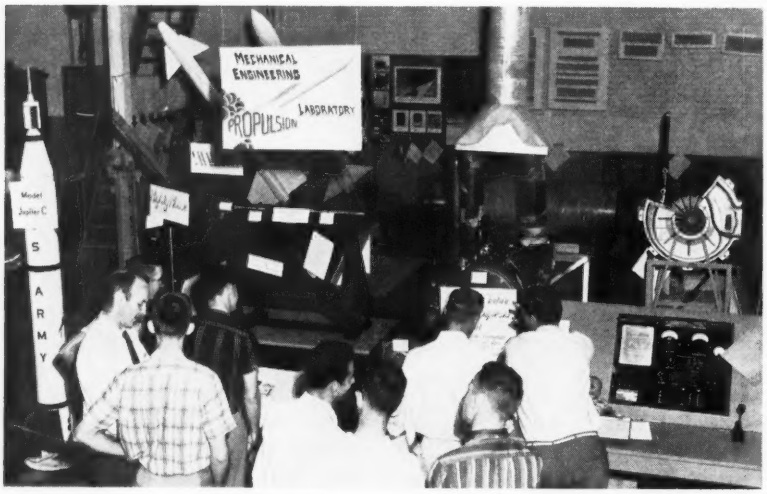
Wichita: In a June dinner meeting, preceded by a social hour sponsored by the Garrett Corp., members heard guest James G. Gaume, M.D., Chief of Space Medicine at Martin-Denver, discuss medical research for lunar operations. Space medicine is becoming a major new field, and the study of lunar operations a focus for research.

—Dean E. Burleigh

For Advancing the State of the Art

Charles J. Giemza, right, engineering supervisor of metals research at Martin-Baltimore, receives Maryland section's annual-award plaque from L. K. Fero, awards chairman, as the section member contributing most to advancing the state of the art in the past year. Giemza played a major role in developing structurally sound beryllium sheet at Martin. Looking on, and looking pleased, is N. E. Felt, section president.

A Propulsion Attraction



Students of the Univ. of Texas chapter, under the direction of K. C. Rathbun, chapter sponsor, helped prepare this propulsion display for the University's 50th Engineering Open House, attended by some 2500 visitors. The display drew much interest and favorable comment.

STUDENT CHAPTERS

Newark: The chapter has new officers, as follows: Dave Broome, president; Richard H. Kroll, vice-president; Arthur Hecht, treasurer; Jim Wojcik, corresponding secretary; and Robert Sorenson, recording secretary.

As to activities, the chapter is currently engaged in the construction of a two-stage rocket for display purposes. This rocket will be used as part of our exhibit at the 75th Anniversary celebration of Newark College of Engineering.

Also, we attended a trip to IBM in Kingston, New York. This trip was sponsored by the ARS New York Student Council. The trip was very interesting and informative. Of particular interest was the Sage computer that, totally from Kingston, was used to trigger a missile at Cape Canaveral and direct it on target.

Two representatives of Convair showed a film of the launching of an Atlas missile. In the past we have shown three other films pertaining to rocketry.

In the future we are looking forward to having more field trips to companies engaged in rocketry and having guests talk on various phases of rocketry.

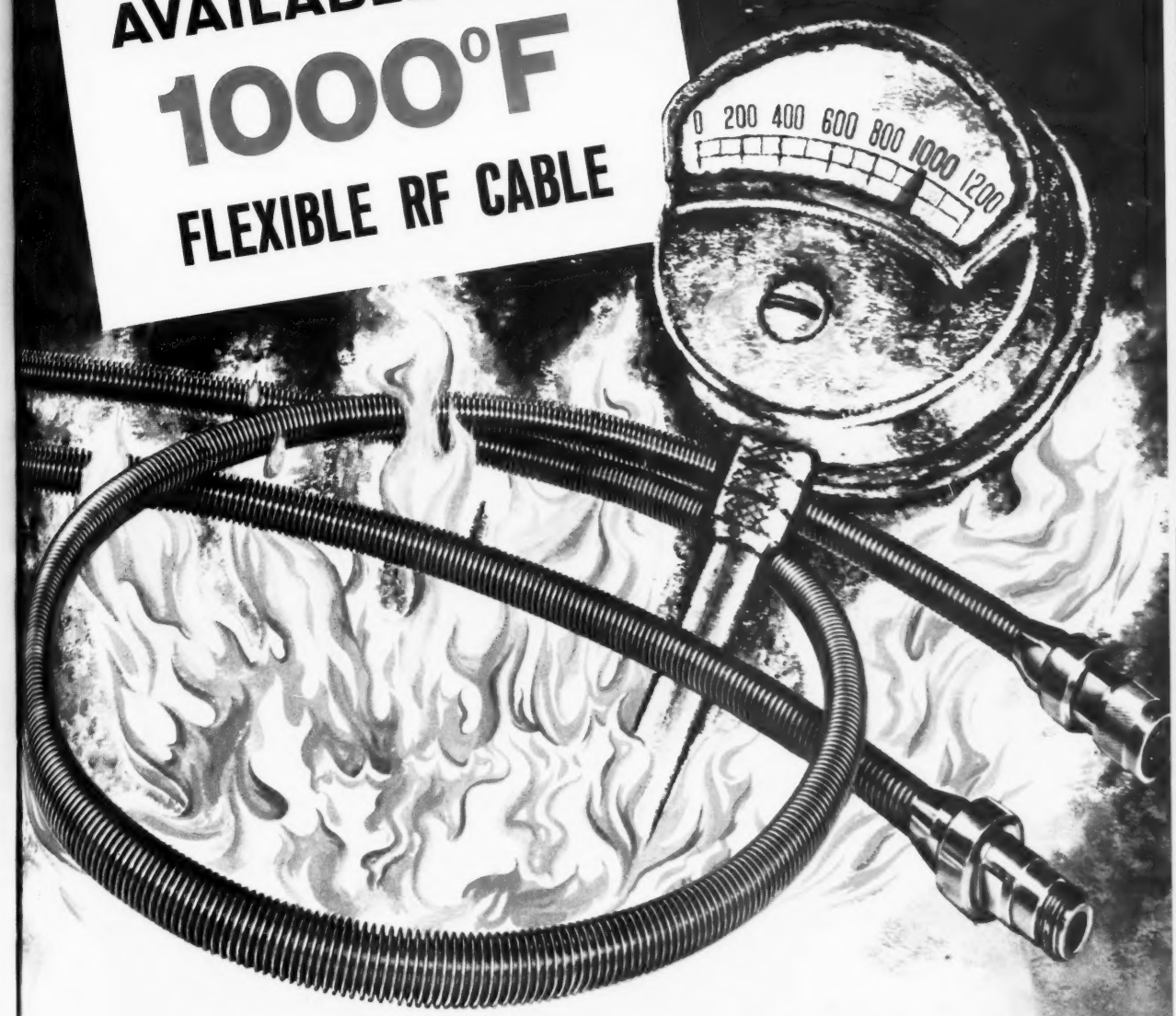
—Richard H. Kroll

St. Ambrose: The installation of this chapter was held on May 21 on the campus of St. Ambrose College, Davenport, Iowa. The ceremony was attended by all members of the chapter as well as other interested students, faculty members, and representatives of neighboring industries, including the Rock Island Arsenal and the Pioneer Central Div. of Bendix Aviation. Nicholas Kass, incoming president of the chapter, introduced the following new officers: George Heenan, interclub council representative; Duane M. Williams, treasurer, Michael O'Leary, vice-president; William Lindquist, secretary; and Edwin M. Vaughan, faculty adviser to the new group.

After this presentation, **Stephen J. Fraenkel,** president of the Chicago section, addressed the group on its privileges and responsibilities as a new student chapter of the Society, and pledged the full cooperation of the Chicago section in support of chapter activities. He laid particular stress on the breadth of educational background needed for a career in the rocket and astronautic fields, and pointed out the excellent opportunity for obtaining this background at an institution such as St. Ambrose. In conclusion, he presented the charter to Nicholas Kass, with best wishes for a successful future.

Univ. of Hartford: At a dinner meeting held in the Rosewood Restau-

AVAILABLE NOW
1000°F
FLEXIBLE RF CABLE



A flexible RF cable that will operate continuously at 1000°F is ready *now* for missile, aircraft, spacecraft and other ultra-high temperature applications. Capable of short time excursions to higher temperatures, the cable is a sealed RF transmission system complete with connectors. It is available in standard lengths up to 200 feet. (Patent Pending)

Delivery: Three to four weeks!

DATA

Altitude Insensitive—Moisture Resistant
Resistant to Shock and Vibration
Resistant to Nuclear Radiation
Connectors: Series N, C and SC
Impedance: 50 Ohms
Capacitance: 30.0 μμf/ft.
Velocity of Propagation: 69.0%
Voltage Breakdown: 3500 Volts RMS
Maximum Operating Voltage: 1000 VRMS
Weight: Cable, 17.5 pounds per 100 feet
Connectors, 2½ ounces each

AMPHENOL

CABLE & WIRE DIVISION

Amphenol-Borg Electronics Corporation

AMPHENOL CABLE & WIRE DIVISION
South Harlem Ave. at 63rd St., Chicago 38, Illinois

☐ Send additional engineering information.
☐ Have AMPHENOL Representative contact me.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

DEPARTMENT OF TECHNOLOGY
BUFFALO ... SCIENCE ... LIBRARY

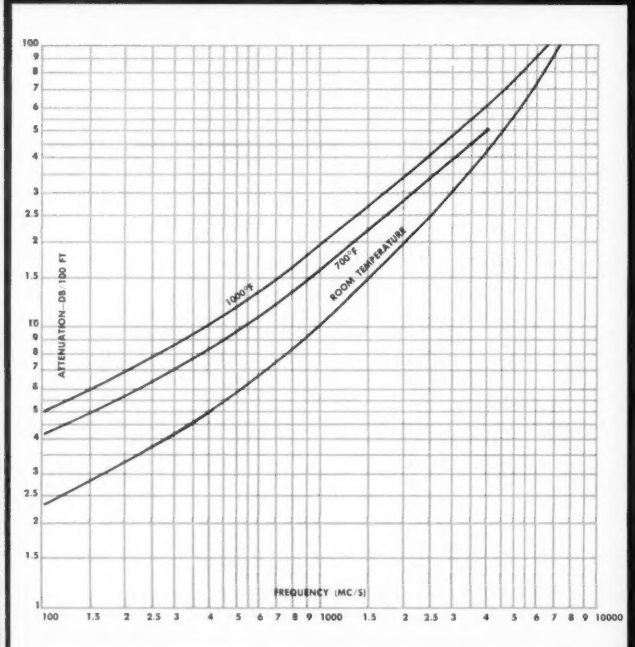
1000°F FLEXIBLE RF CABLE

PHYSICAL CHARACTERISTICS

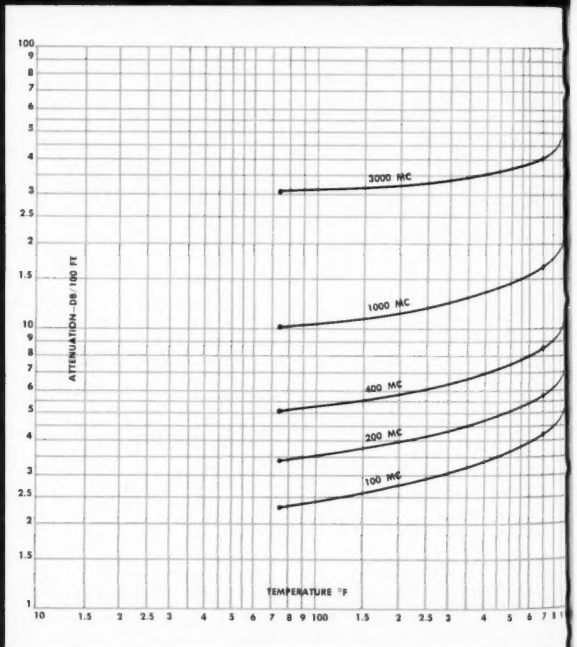
DESCRIPTION	CONSTRUCTION DETAILS
Inner Conductor	Stranded coated oxygen-free, high-conductivity copper wire.
Cable Core	Modified semi-solid silica.
Outer Conductor	Single braid, AWG size 32 coated oxygen-free, high-conductivity copper wire.
Jacket	Flexible special metal alloy. Nominal overall diameter: .525".

FLEXING CHARACTERISTICS

Cable can be bent on a 10X mandrel (bend diameter=10X diameter of cable). Cable dielectric shows no deterioration after 30,000 cycles of bending over 10X mandrel in accordance with specification MIL-C-915.



ATTENUATION VS. FREQUENCY AT ROOM TEMPERATURE, 700°F and 1000°F



ATTENUATION VS. TEMPERATURE AT VARIOUS FREQUENCIES

(See Other Side)

AMPHENOL

CABLE & WIRE DIVISION

Chicago 38, Illinois

Amphenol-Borg Electronics Corporation

rant, Weatogue, Conn., **Carl W. Lemmerman**, president of the Connecticut Valley section of ARS, presented this new student chapter its charter. Edgar H. Brisson, then chapter president, accepted the charter for the members.

The evening featured two talks, one by this distinguished guest, on "Applications of Rocketry to the Space Age," and one by **Alexander H. Zerban,** Dean of University's School of Engineering, on current rocket projects at the school. Among these projects is a steam-propelled rocket, now under construction, for thrust measurements in the laboratory.

In a following meeting, the chapter elected these new officers: Joseph Brown, president; Robert W. Taylor, vice-president; Neale F. Laurence, secretary; and Edward Duroter, treasurer.

—Neal F. Laurence

Univ. of Texas: The Univ. of Texas 50th Engineering Open House held in May, with the participation of the chapter, was attended by more than 2500 visitors. The propulsion laboratory display, under the direction of K. C. Rathbun, ARS member and sponsor of this chapter, consisted of several rocket motors, turbines, ramjets, and missile configurations (see page 70). Most of the displays consisted of work which students themselves, mostly ARS members, are doing in the propulsion field as part of their contribution to University's Mechanical Engineering Propulsion Systems Laboratory. These displays were very successful, and in our opinion the chief attraction of the Open House. The chapter plans to make this a permanent annual project.

The members of the chapter are indebted to Chance Vought Aircraft for the loan of three missile mockups; to Fred C. Jonah, one of our advisers, for help in this project; and to Chrysler Corp. for a model of Jupiter-C.

—E. F. Infante

TECHNICAL COMMITTEES

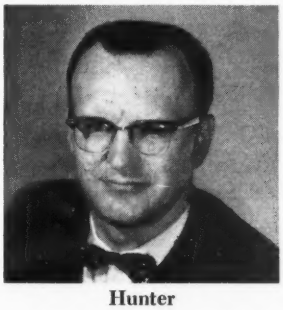
Hypersonics: Committee Chairman William H. Dorrance has announced the following appointments to the Hypersonics Committee: H. Julian Allen, Palo Alto, Calif.; Alfred J. Eggers, Los Altos, Calif.; Wallace D. Hayes, Princeton Univ.; Lester Lees, Caltech; Ting Y. Li, R.P.I.; Richard D. Linnell, San Diego, Calif.; Eugene S. Love, NASA Langley Research Center; Henry T. Nagamatsu, GE; Frederick R. Riddell, Avco Mfg Co.; George E. Soloman, Space Technology Labs; and Peter P. Wegener, Jet Propulsion Lab.

Dorrance

Ion and Plasma Propulsion: Committee Chairman David B. Langmuir has named the following to be members of the Ion and Plasma Propulsion Committee: Robert H. Boden, Rocketdyne; William C. Cooley, NASA; Russell Edwards, GE; Robert Fox, Univ. of California Radiation Lab; Charles R. Hudson, WADC; Edward L. Resler, Cornell Univ.; Nathan W. Snyder, ARPA; and Ernst Stuhlinger, ABMA.

Langmuir

Missiles and Space Vehicles: Committee Chairman Maxwell W. Hunter has named the following to be members of the Missiles and Space Vehicles Committee: R. W. Detra, Avco Mfg.; R. B. Demoret, Martin Aircraft; George S. Graff, McDonnell Aircraft; Weyland Griffith, Lockheed Aircraft; Douglas W. Hege, Rocketdyne; Col. L. B. James, ABMA; Hilliard Page, GE; W. K. Ritter, NASA; Kurt Stehling, NASA; A. K. Thiel, Space Technology Labs; and David Young, ARPA.



Hunter

Ramjets: Committee Chairman William B. Shippen has announced the make-up of the Ramjets Committee. Members are: B. F. Beckelman, Boeing Airplane; Dwane P. Crowl, Marquardt; Franklin P. Durham, Los Alamos Scientific Lab; Raymond

RESEARCH AND DEVELOPMENT ENGINEERS AND SCIENTISTS

Exceptional opportunities in the field of thermodynamics.

At least five years experience or training required. Must have knowledge and understanding of theoretical. experimental work and ability to direct activities of engineers in the following areas:

Aerodynamics Heating of Aircraft Structures

Gas Dynamics of Real Gases

Thermodynamics—Engineering, Chemical, Statistical

Heat Transfer

Gaseous Radiation

Hypersonic and Space Vehicle Design

For more information please write to: Mr. H. U. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF

NORTH AMERICAN AVIATION, INC.

PROPULSION ENGINEERS *Wanted by* CHRYSLER MISSILE DIVISION

Positions available for experienced Propulsion Systems Design Engineers to participate in some of the most advanced space research activities being conducted. PROJECT MERCURY and additional classified research programs, along with continuing Redstone and Jupiter operations, afford excellent opportunities for career development and professional advancement.

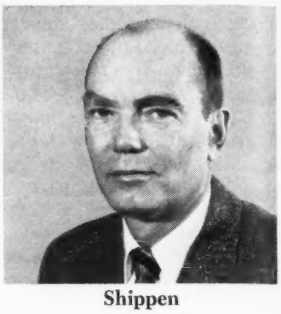
Responsibilities involve rocket engine propulsion systems design, development and test; including rocket propellants (liquid and solid), thrust chamber, gas generating systems, and controls. These positions also require the ability to conduct customer and sub-contractor liaison, supervise technical personnel and write engineering reports.

A BS degree in ME or AE (advanced degree preferred) with five years' aircraft, rocket, or missile experience required. In addition, 2–3 years' general engineering experience at the Project or Assistant Project Engineering Level is required.

Candidates selected for these rewarding positions will be reimbursed for relocation expenses and will enjoy excellent starting salaries, professional challenge, and equal opportunity for personal advancement.

Submit a complete resume in confidence to **Mr. L. G. Olsen, Personnel Department, 220 P, Chrysler Corporation, Missile Division, P. O. Box 2628, Detroit 31, Michigan.**

All replies will be promptly acknowledged.



Shippen

Greenburg, Curtiss-Wright; James N. Mullen, Experiment, Inc.; Eugene Perchonock, Marquardt; H. R. Saffell, Wiancko Engineering Co.; and Frank I. Tanczos, Navy Bureau of Ordnance.

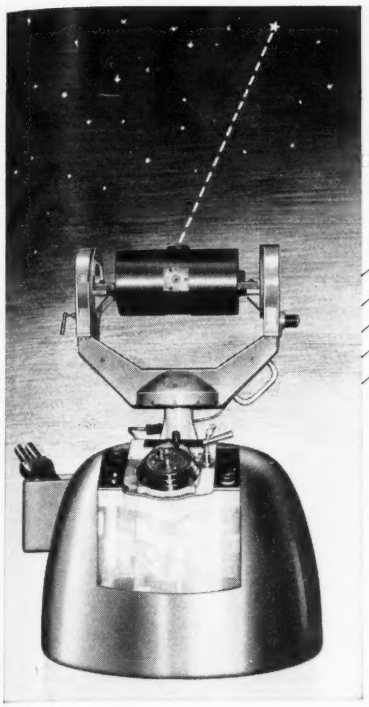
Solid Rockets: Committee Chairman Ivan E. Tuhy has named the following to be members on the Solid

Tuhy

Rockets Committee: William C. Fagan, WADC; A. Terrell Jones, ABMA; H. Griffeth Jones, Thiokol Chemical; Fred K. Guest, Space Technology Labs; Emil A. Malick, Phillips Petroleum; John R. McDonald, Astrodyne; Arch Scurlock, Atlantic Research Corp.; Lt. Comdr. Edward Sheehey, Navy Bureau of Ordnance; Capt. Robert Sherman; I. A. Spitzer, Grand Central Rocket Co.; and David F. Sprenger, Aerojet-General.

Underwater Propulsion: Committee Chairman George F. Wislicenus has announced the make-up of the Underwater Propulsion Committee. Members are: Robert C. Brumfield, Operations Research, Inc.; Calvin A. Gongwer, Aerojet-General; Leonard Greiner, Experiment, Inc.; and Herman E. Sheets, General Dynamics.

Wislicenus



Do you need

EXTREMELY ACCURATE TEST STANDS FOR

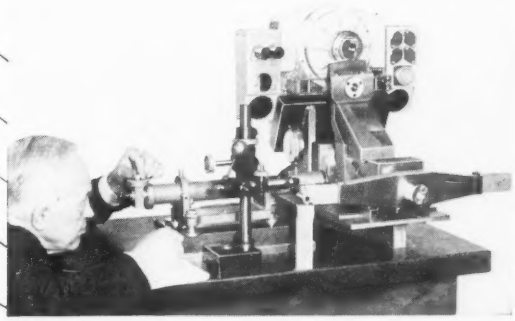
Inertial Guidance Systems?

see VINCO

Precision has been Vinco's most important product for more than thirty years. The ability to work to extremely close tolerances is an indispensable asset to the missile manufacturer requiring Gyro System Test Stands.

Vinco manufacturers extremely accurate test stands complete with gearboxes. These gearboxes isolate the Gyro System from the effect of the earth's rotation. Vinco invites you to submit your guided missile test stand problems.

Inspection of a Vinco Sidereal Gearbox by an autocollimator and polygon reflector segment. Output accuracy limit of complete gear train is 3.6 seconds of arc; gear ratio 2,584,800 - 1.



VINCO CORPORATION
9111 Schaefer Highway
Detroit 28, Michigan

Senior staff openings in basic research

THE BOEING SCIENTIFIC RESEARCH LABORATORIES are engaged in a program of fundamental research designed to make contributions to the progress of the physical sciences. High-level staff positions are open now in the fields of

Gas Dynamics
Plasma Physics
Mathematics
Solid State Physics
Electronics
Physical Chemistry
Geoastrophysics

Boeing grants scientists the latitude and independence needed to achieve and maintain leadership in their special fields. Scientists interested in carrying on their work in this kind of stimulating research environment are invited to communicate with Mr. G. L. Hollingsworth, Director, Boeing Scientific Research Laboratories.

P. O. Box 3822 - ATB
Boeing Airplane Company
Seattle 24, Washington

BOEING

From the patent office

By George F. McLaughlin

Rocket Grain Seal Protects Thin Motor Tubing

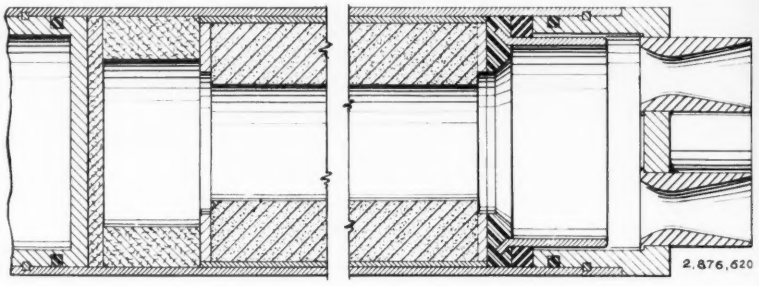
Although desirable for its lightness, thin-walled tubing for solid propellant rocket pressure vessels is impractical unless hot gases can be prevented from flowing between the inner wall of the tubing and the facing surface of the propellant grain. Such a flow of hot motor gases usually burns through the tubing, destroying the motor or markedly deflecting its line of thrust.

Difficulty in preventing such gas leakage stems from differences in thermal expansion coefficients of propellant-grain and motor-tube materials. That is, the expansion coefficients of the class of solid propellants considered with this proposed invention are very high compared with the materials practical as tubing.

The invention entails a resilient ring to make a gastight seal between the after end of the grain and a cupshaped nozzle plate. A damped compression ring at the forward end of the motor forces the grain in the direction of the nozzle plate, maintaining the obturator elements in gastight engagement. This relationship is maintained despite differential expansion and contraction of the grain and the other components. The damped resilient support also absorbs impact forces incident to handling the rocket.

The invention may be manufactured or used by the U.S. Government without paying royalties to the inventors.

Patent 2,876,620. Rocket Motor. Clarence E. Weinland (ARS member) and Arthur C. Ellings, U.S. Naval Ordnance Test Station (NOTS), China Lake, Calif.



Longitudinal section of rocket motor with sealing system.

Solar Energy Converter

North American Philips Co., Inc., has been assigned a photovoltaic device to convert solar energy. It consists mainly of portions of aluminum antimonide semiconductor forming a p-type junction. Electrical connections are made to the two portions. One portion has a surface area adapted to receive solar energy.

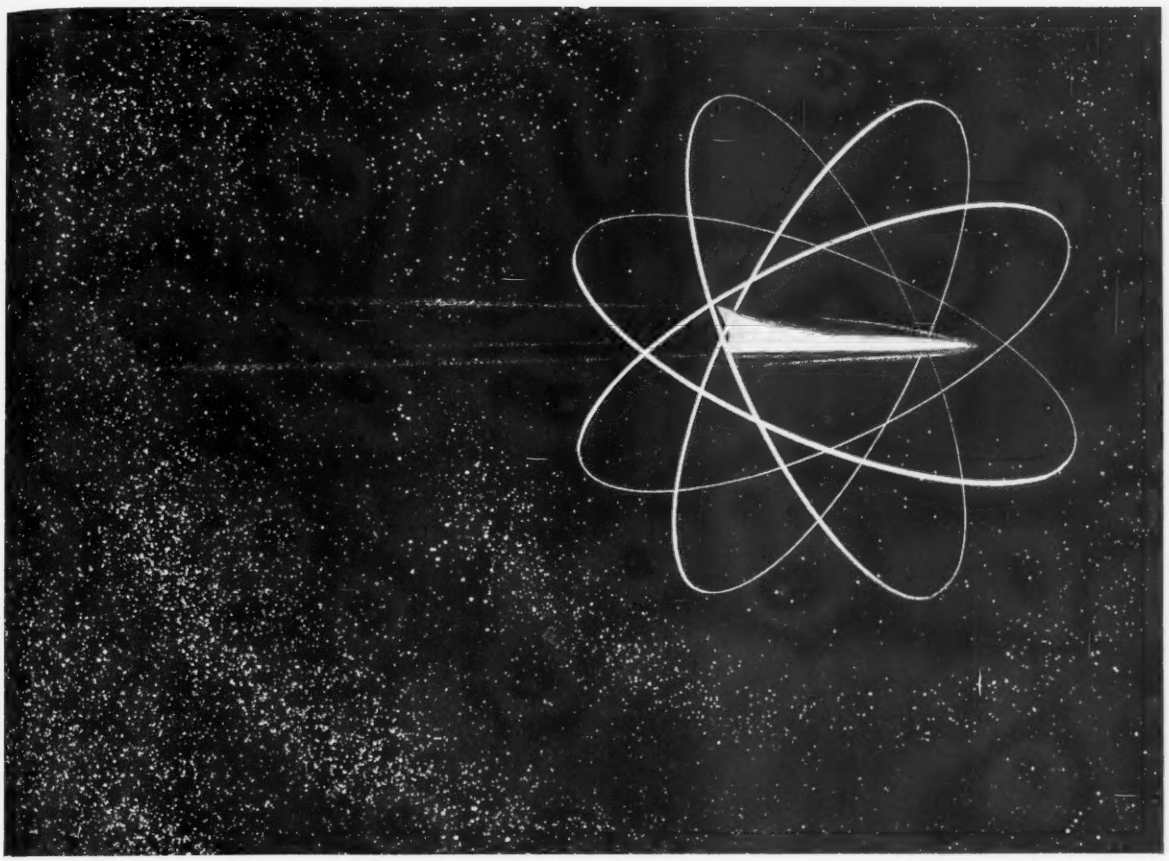
Patent No. 2,873,303. Photovoltaic Device. Edmond S. Ritter, White Plains, N.Y.

NSF Begins Publication Of *Science Information News*

The National Science Foundation has begun publication of a new bimonthly magazine, entitled *Science Information News*, designed to report on national and international developments in scientific and technical information. The first issue, dated February-March, is slanted largely toward NSF activities, although later issues are expected to provide full-scale coverage of the field. The publication is available from the Superintendent of Documents, U. S. Govt. Printing Office, Washington 25, D. C., at a cost of 25 cents per single copy or $1.25 per year.

Distillation Separates Hydrogen Isotopes

The NBS Cryogenic Engineering Laboratory at Boulder, Colo., has demonstrated practical fractional distillation of hydrogen isotopes at low temperature to yield liquid deuterium and deuterium-free hydrogen.



a fence in the sky

The Westinghouse Air Arm Division has been selected to develop and build a fence in the sky . . . an electronic defense system to shield the Air Force's 2000 mph B-70 Valkyrie.

This defense system will be a new dimension in electronic counter-measures, employing electro-magnetic and other techniques to delay, confuse and distort enemy intelligence. With its advanced technical developments, this system will greatly increase the manned aircraft's capacity for self defense.

The program, including advanced development and design work, will offer unique career development opportunities for engineers desirous of pioneering in the following fields:

AIRBORNE ELECTRONIC COUNTER-MEASURES

Systems Engineers
Broad Band Amplifiers
Signal Analysis
Digital Computer Design
Microwave Tube Design
Antenna Design

CONTROLS & DISPLAYS

Circuit Design
Experimental Psychologists

GROUND SUPPORT EQUIPMENT

Automatic Check-out and Fault Isolation

FERRET RECONNAISSANCE
ELECTRONICS INSTRUCTORS
COMMUNICATIONS CIRCUITRY
FIELD ENGINEERING
TECHNICAL WRITING
ELECTRONIC PACKAGING

FOR DETAILS . . . and a copy of the informative brochure "New Dimensions", send a resume of your education and experience to: Mr. A. M. Johnston, Dept. 939 Westinghouse Electric Corporation, P. O. Box 746, Baltimore 3, Maryland.

Westinghouse
BALTIMORE

People in the news

APPOINTMENTS

Capt. Robert C. Truax, USN-Ret. and former ARS national president, has been appointed director of advanced development at Aerojet-General's Liquid Rocket Plant. He will be in charge of the plant's investigation of new propulsion systems, propellants, and related areas. Capt. Truax is holder of the Navy Legion of Merit for his contribution to the Polaris program and recipient of the ARS Robert H. Goddard Award (1951).

Ira H. Abbott succeeds John W. Crowley Jr. as NASA director of aeronautical and space research. **Jacob M. Roey** has been named to the newly created position of small business adviser.

Herbert York, director of DOD research and engineering, has named **John H. Rubel** assistant director for strategic weapons. Rubel takes a leave of absence from Hughes Aircraft where he has been director of airborne systems laboratories. Max T. Weiss joins Hughes as senior staff physicist of the microwave laboratory's Electronics Research Dept. **Earl L. Steele,** former research chief, Motorola, Inc., has been appointed assistant manager of the development laboratory, Semiconductor Div. of the Products Group. **George C. Messenger** has joined the Products Group as head of the Device Electronics Dept., and **Michael Waldner,** becomes a member of the technical staff, Device Research Dept.

President Eisenhower has appointed **James H. Wakelin** assistant secretary of the Navy for R&D.

Richard F. Howe, former manager of Avco's Lycoming Missile Systems Dept., has been named assistant plant manager of the Stratford, Conn., plant, while **Immanuel Lichtenstein** becomes assistant to the president for planning.

John B. Darrah has been appointed vice-president and general manager of the Budd Co.'s Defense Div.

Herbert Trotter Jr., former executive vice-president, Sharples Co., has been elected senior vice-president of engineering and research at Sylvania Electric Products, Inc. **J. Earl Thomas Jr.,** former head of the Physics Dept. at Wayne State Univ., has been named director of research and engineering, Semiconductor Div.

Walter R. Dornberger, director of engineering, Bell Aircraft's Niagara Frontier Div., has been elected a vice-president.

Y. C. Lee has been named manager of Aerojet-General's newly formed Space Technology Div. Activities of the division and the Systems Div., managed by **Marvin L. Stary,** will be coordinated with the newly organized Space Systems Directorate consisting of **A. L. Antonio,** vice-president, Chemical Div.; **W. L. Rogers,** vice-president, Azusa Operations; **Lee;** and **Stary.** In other appointments, **Carl R. Malstrom,** former manager of R&D, Rheem Mfg. Co., has been named assistant general manager, Aerojet Nucleonics, while **Hubert P. Yockey,** former assistant director, Health Physics Div., Oak Ridge National Lab, becomes assistant technical director. **Victor E. Caffee,** manager of materiel, Azusa plant, will also serve as assistant director of materiel. **Robert L. Hirsch** will head the Washington, D.C., office.

Robert Bruce Cox, former senior research engineer, has been named chief engineer, Cooper Development Corp.

Milton D. Van Dyke, former research scientist at NASA's Ames Research Center, has been made professor of aeronautical engineering at Stanford Univ.

Thomas V. Jones, former senior vice-president, Northrop Corp., has been elected president. **James Allen,** former vice-president and assistant to the president, becomes corporate vice-president and assistant to the board chairman.

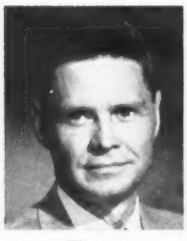
Anthony C. Cuomo has been promoted to assistant manager of the Missile Support Lab, Allen B. Du Mont Labs, and **Charles R. Wilson** from quality control manager, West Coast Div., to production manager of the division's Military Electronic Operations.

William B. Hebenstreit becomes program director for communication satellites and **Robert O. Wickersham** director of the program management staff, in the Systems Engineering Div. of Space Technology Labs. Hebenstreit formerly was director of special programs. **George S. Cherniak,** former head of STL's Atlas Project Office at Cape Canaveral, has been promoted to director of the company's Flight Test Operations, Atlantic Missile Range, and **H. J. Doane,** becomes associate head of the Thor Project Office, Flight Test Operations at Canaveral. **Allan F. Donovan,** vice-president and director of Advanced Systems Planning, has been named a delegate to a panel of technical experts which will advise the U.S. Committee on Nuclear Testing.

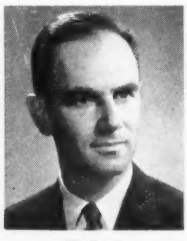
Albert D. Emurian, former engineering manager, Data Transmission Systems, Government and Industrial Div. of Philco Corp., has joined Hoffman Electronics Laboratories Div. as east coast manager of its phase of the Air Force's global communications complex Air Com.

Samuel B. Sherwin has been appointed manager of United Aircraft's Ketay Dept. in the Norden Div. **Wladimir Reichel,** Norden's chief of basic design, assumes the additional post of engineering manager, Ketay Dept.

King D. Bird transfers from head, Transonic Tunnel Dept., to head of the new Hypersonic Tunnel Dept. at Cornell Aeronautical Laboratory, while **James F. Martin** becomes assistant head. **John P. Andes** succeeds Bird, and **Ray W. Cotter** becomes assistant head of TTD. **Roger W. Walker** has been named program development manager, Government-Industry Relations; **Ralph F. Foltz**


Truax

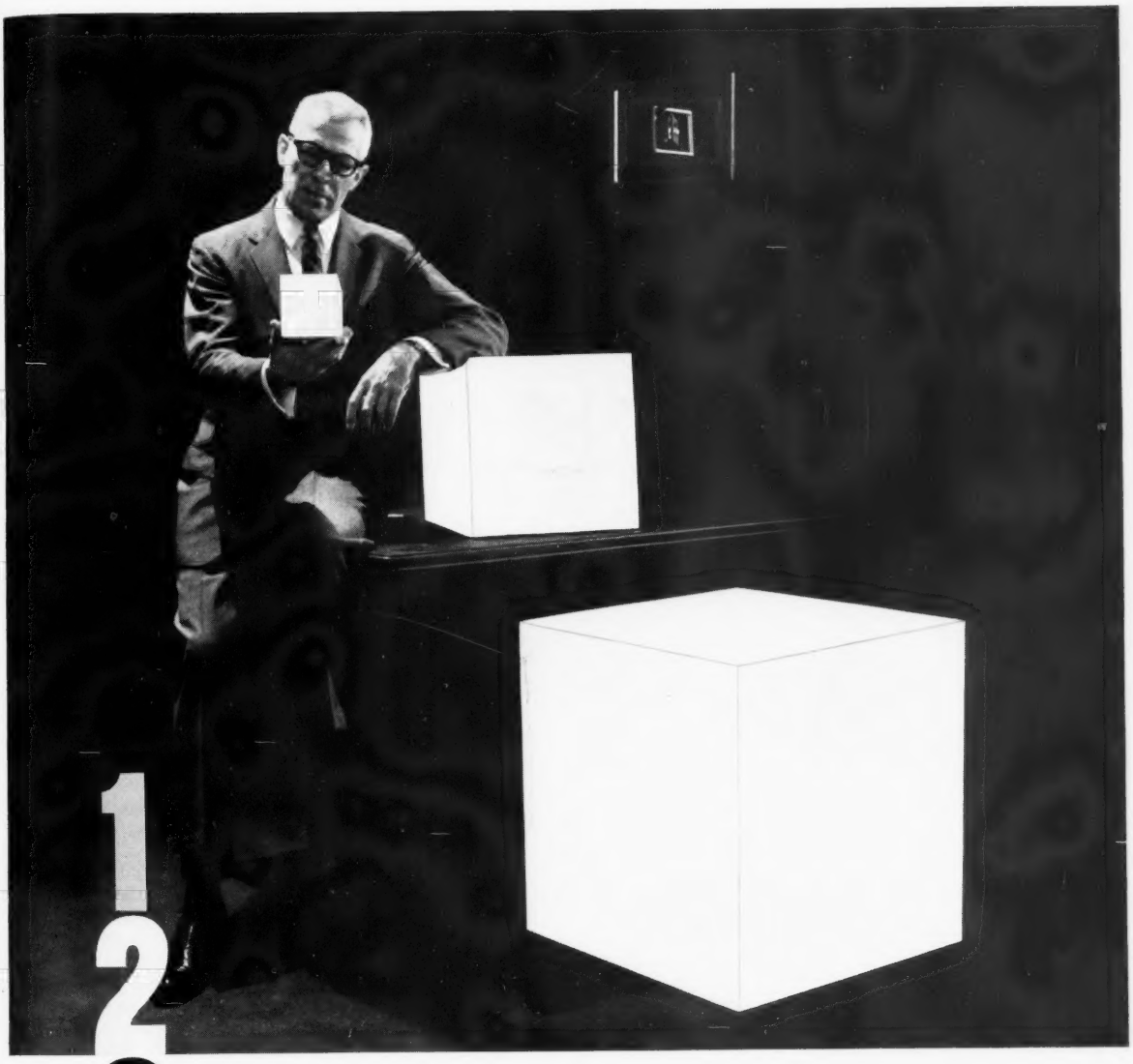
Abbott


Rubel

Trotter

Cox

Wickersham



1 2 3 generations of airborne digital computers (but we can't show you their configurations)

In the photo above, the three ARMA computers have been intentionally deleted. But the cut-outs accurately represent the relative size of the three generations of ARMA airborne digital computers.

The larger size has been *in production* since 1957. The middle-sized one (a quarter the size of today's) will be in production in 1960. And the micro-miniaturized version in the engineer's hand will be operational in 1962—only .3 cubic feet in volume.

A production line unit of ARMA's current model has operated in excess of 4000 hours without a component replacement. And the 1960 and 1962 versions will have reliability factors at least equal to this.

With this program of miniaturization, ARMA has made the digital computer truly airborne. ARMA . . . Garden City, New York. A division of American Bosch Arma Corporation.

6939

We invite you to visit our booth at the Wescon Show, San Francisco.

AMERICAN BOSCH ARMA CORPORATION

Campbell

Register

Howard

Perry

Korman

Bauschinger

succeeds Walker as assistant contract manager.

Harry Nyquist has been named staff scientist in the Research and Development Div. of W. L. Maxson Corp.

D. M. Heller, assistant general manager, Bendix Missiles Section, has been transferred to the staff of George E. Stoll, vice-president and group executive, Bendix Aviation, South Bend, Ind.

James O. Seamans, former Sparrow III technical director at Raytheon's Bedford Labs, has been named Sparrow III program manager for the Missile Systems Div. **W. Rogers Hamel** will head the company's new Anti-Submarine Warfare Center. **Wilbert E. Stevenson,** president and director of Machlett Labs, a subsidiary, has been elected a vice-president of Raytheon.

Robert V. D. Campbell, former deputy director, Burroughs Corp. Research Center, has been promoted to director of research. **Charles L. Register,** manager, Ballistic Missile Div. becomes manager of the Great Valley Lab, and **John H. Howard,** manager, Research and Development Div., assumes the same post at the Paoli Lab.

Robert W. Perry will head the Reentry Simulation Lab and **Samuel Korman** the Materials Development Lab of Republic Aviation's new $14 million Astronautical Research Center. **Robert P. Bastian** and **Stanley Zirinsky** have been named chief chemist and chief metallurgist, respectively, of the Materials Development Lab. Perry formerly was manager of the research branch, gas dynamics facility at Arnold Engineering Development Center in Mexico; Korman, former AEC consultant; Bastian, engineering specialist in analytical and inorganic chemistry, Sylvania Electric Products; and Zirinsky staff consultant to GE Missiles and Space Vehicles Div.

Oscar H. Bauschinger, former head, Engineering Dept., Ford Instrument Co.'s Missile Development Div., has been appointed Jupiter Project Manager for the company.

Maj. Gen. E. Blair Garland, AF-Ret., has joined Philco Corp.'s Government & Industrial Div. as manager of a new military communications group. **Henry E. Hockeimer** has been named Aircom project director, while **Donald B. Clyman** becomes administration and services manager; **Morton L. Long,** engineering manager; and **John Pell,** installation manager.

Robert G. Brault, former supervisor of subcontract research and coordinator of high-energy fuel projects, Callery Chemical Co.'s R&D Labs, will head the company's West Coast office near Los Angeles.

Harold M. Kneller, former preliminary design engineer, United Aircraft Corp., has been named director of defense and special projects operation for the Underwood Corp.

Allen Latham Jr., vice-president of Arthur D. Little, Inc., has been named to the Advisory Panel of the National Bureau of Standards' Cryogenic Engineering Div.

William C. Knopf, former assistant director of research, International Minerals and Chemical Corp., has been named technical director of the USI Technical Center, Div. of U.S. Industries, Inc.

William C. Benson, former manager of support equipment sales, Beech Aircraft Corp., has been named project engineer, ground support equipment for Solar Aircraft Co.

Robert E. Samuelson, former engineering manager, Military Electronics Center, Motorola Inc., has been appointed to the new post of assistant general manager for research and development.

Rawlings

Smith

John K. Elder, has been appointed vice-president, Applied Research and Testing Labs, Rocket Power, Inc., a subsidiary of The Gabriel Co.

Wilbert H. Yahn has been elected a vice-president of North American Aviation, and appointed general manager of the Columbus, Ohio, Div. **Richard F. Walker** has been appointed assistant general manager at Columbus.

Vernon Rawlings, former director of Martin Co.'s Manufacturing Div., has been named general manager of the newly formed Activation Div. **J. Donald Rauth,** general manager of the Nuclear Div., has been elected a vice-president of the company. **George E. Smith** has been named general manager of the Cocoa Div. at Cape Canaveral, succeeding **G. T. Willey,** who recently became vice-president and general manager of the Orlando Div.

Howard M. Wittner, former manager of a space-vehicle project operation at General Electric, has been named manager of the new advanced systems engineering operation, Missile and Space Vehicle Dept. Suboperation managers are **Robert L. Francisco, C. Frank Hix Jr., Richard A. Passman, Robert R. Reid, Stanley C. Tracz,** and **L. W. Warzecha.**

Collins Radio Co. has appointed **J. C. McElroy,** director of development and **R. L. McCreary,** director of research of its new Cedar Rapids Div. **A. S. Born** will serve as assistant to Vice-President R. T. Cox.

George Canova has joined Datex Corp. as senior project engineer in the systems group.

Lester L. Kilpatrick has been made president of California Computer Products, Inc. at Downey, taken over by Kilpatrick and other former personnel at Autonetics. The others and their respective positions are **Ronald D. Cone,** engineering vice-president; **Eugene Seid,** vice-president; **Robert C. Morton,** vice-president; and **Gene W. Beckman,** secretary-treasurer.

Joel M. Jacobson, vice-president and general manager, Aircraft Armaments, Inc., has been elected president.

(CONTINUED FROM PAGE 25)

in the skulls of mice have been shown capable of profoundly modifying their behavior patterns, presumably through direct action on their cranial "pleasure centers." This points to a similar possibility for controlling the actions of human beings, if desired or permittted by the people.

14. Certain chemicals are known to be capable of modifying human behavior patterns, and these modifications can take a wide variety of forms. For example, it may be possible to cure certain forms of insanity by means of simple chemicals.

15. It may be possible to develop a small pill which, taken orally, can both render a woman temporarily sterile and at the same time improve her general health. Profound changes in some of our social customs and beliefs could be expected to accompany the widespread availability of such a pill.

16. Some recent experiments indicate the possibility that parents might eventually be able to choose the sex of their children.

17. It seems clear that man could control his own biological evolution in many different ways, and into many different directions, if he so desired.

18. I venture to predict that a "science of values" will soon arise. I mean by this that we can put various kinds of human groups into isolated but controlled environments, and then see what ethical value systems evolve and how well-fitted for survival the resulting communities are. The implications of such sociological studies and experiments would be far-reaching.

19. There are experiments which suggest that man might not need to die, biologically speaking.

20. It seems possible to develop atom bombs that will fit into a suitcase, in a weight that a man can carry.

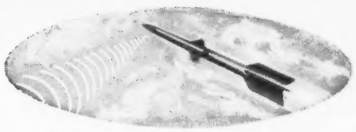
21. It seems clear that nearly all the world's nations have scientists who can eventually succeed in designing and making their own atom bombs.

The foregoing list of future possibilities is not exhaustive; it can be extended nearly indefinitely. A similar list describes those things that science today tells us we cannot do. Such a list could, I believe, include the following:

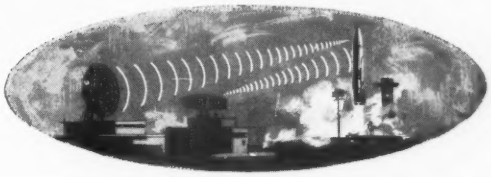
1. We do not think an "anti-gravity screen"—fabeled in science fiction—is possible of development.

2. We do not think energy can be created except by the vanishing of proportionate quantities of mass. Most scientists believe that energy and mass, taken together in the proper ratio, represent a fixed and constant

Interested in Systems Engineering?



There are systems



...and systems

...and TOTAL systems in which the big bird and support equipment may rank only as a component.

This difference between systems can make a big difference in your career

IF YOU ARE QUALIFIED and interested in contributing to programs of "total" scope, it will be of value to you to investigate current opportunities with General Electric's DEFENSE SYSTEMS DEPT., whose work lies primarily in providing *total* solutions to large scale defense problems of the next 5, 10 and 20 years.

The work here lies almost entirely in the areas of systems engineering and systems management.

Inquire about these positions:

- Guidance Equation Engineers
- Systems Logistics Engineers
- Electronic Systems Management Engineers
- Operations Analysis Engineers
- Systems Program Engineers
- Data Processing Engineers
- Systems Test Evaluation Engineers
- Engineering Psychologists
- Radar Equipment Engineers
- Weapons Analysis Engineers
- Weapons Systems Integration Engineers
- Engineering Writers

Forward your confidential resume at an early date.
Whereas the growth potential is evident — both for DSD and the engineers who join us — the positions we fill during these early months will carry significant "ground-floor" benefits.
Write fully to Mr. E. A. Smith, Room 8-A.

DSD DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division

GENERAL ELECTRIC

300 South Geddes Street, Syracuse, N. Y.

Why Boeing offers ENGINEERS AND SCIENTISTS better opportunities to advance

If there is a lingering doubt in your mind about the future in your present position, this message will be of particular interest—and value—to you.

Opportunities for advancement are tied very closely to the growth prospects of the company you're with. Boeing, for instance, is expanding rapidly in areas with an extremely long-range future—missiles and space-age projects. This growth provides outstanding opportunities for engineers and scientists to move up to higher levels of responsibility and income. It also promises career stability.

Another advantage you enjoy at Boeing is a dynamic career environment that's conducive to rapid advancement. You work in a small group, with high visibility for your individual talents and accomplishments. You are encouraged to take graduate studies in your special field, at company expense. You're eligible for management courses designed to help you get ahead faster.

Assignments at Boeing are on some of the most exciting projects in the country: a boost-glide vehicle; Minuteman, an advanced solid-propellant intercontinental ballistic missile system; BOMARC, the nation's longest-range supersonic defense missile; jet aircraft of the future; orbital, lunar and interplanetary space systems.

There are challenging, get-ahead opportunities at Boeing, now, for engineers and scientists of virtually all experience levels, with educational backgrounds from B.S. to Ph.D. Openings are available in Research, Design, Production and Service. They could well be the answer to *your* future.

Write *today* for your free copy of the 24-page book "Environment for Dynamic Career Growth." Indicate your degree(s) and field of interest. Address: Mr. Stanley M. Little, Boeing Airplane Co., P.O. Box 3822-ARC, Seattle 24, Washington.

BOEING

Seattle • Wichita • Cape Canaveral

total in our locality of the galaxy.

3. We do not think it possible to get useful work from any large fraction of the vast quantitity of heat energy in the oceans.

4. We do not believe the simultaneous measurement of the position and velocity of a particle of matter can be reduced in uncertainty below a definite, known numerical value.

5. We believe one can compress only a definite, maximum amount of information into a given "time-bandwidth product" for a given communication channel.

6. We do not think it possible to perform an experiment which measures the "absolute speed" of our earth, say, relative to any postulated "absolute space."

7. We do not believe it possible to design an H. G. Wellsian "time-traveling" machine.

8. We do not believe it will ever be possible for any actual material body to remain structurally solid if its average temperature rises above a few thousands of degrees F.

To this list, I might add—out of my own experience as a weapons scientist—that I do not feel it is possible to provide 100 per cent effective military defense of a large traget, such as the U.S. or the U.S.S.R., against all the various ways it can be attacked by a determined enemy armed with atom bombs.

What will our future societies be like? No one can answer this question, but some surmises and observations are possible.

First of all, I think an Orwellian "1984" world is possible, but it presupposes a degree of control over the individual that many of us would strongly resist, and it is therefore unlikely of full and long-term development. Tendencies toward such a society will always be present and visible to a greater or lesser degree. Therefore, continued and enlightened vigilance by each citizen in defense of our fundamental civil liberties is perhaps the first requirement to prevent development of an all-pervading and oppressive state.

I suspect a world government will emerge as the major powers jostle uneasily in a variety of small conflicts. During this evolution, there will no doubt be many shiftings of alliances, and also much chest-thumping about the absolute rights of sovereign nations. Eventually, the atom bomb will probably be policed out of existence, along with the national stockpiles of long-range ballistic missiles, long-range bombers, and military submarines and warships. This, if it comes, will signify, to my mind, that a world government has, in fact, begun to operate.

During this phase, we shall no doubt see further developments in worldwide travel and television, including, perhaps, automatic language-translation devices. World civilization will probably exhibit extreme turbulence and much international controversy, as well as much actual violence, ranging from individual murder and mayhem to some limited international wars.

A most urgent problem today is world overpopulation. Here, the contraceptive pill will probably play a decisive role. Social restraints will not by themselves work fast enough, in my opinion, to solve this crucial problem. If we fail to develop "the pill," we can look forward to a really catastrophic war, or else perhaps to a social existence much like that of India, China, and Japan in the early years of this century. Neither of these latter possibilities offers an inviting prospect. The possible colonization of other planets than earth holds out no hope, in my opinion, of solving the population problem.

Death Has Social Role

Death, to my mind, plays a socially necessary and valuable role, no matter how distasteful it may be to any particular individual. For, I ask, how would we have room for children and for new ideas and for joy if we were to eliminate natural death? Indeed, I personally feel that we should soon institute artificial death if we were ever to succeed in conquering natural death. In some of the world's cultures, artificial death has for long been a socially-accepted institution.

When we succeed in learning how to control the sizes of the polar icecaps, we shall urgently require a world government to make possible the existence and enforcement of international agreements regarding the level of the sea. Likewise, control of the earth's average temperature is a matter of vital interest to every nation, great and small.

We may well ponder the impact of our present-day economy and value system of the existence of essentially unlimited energy under our control. It could mean that manual labor would become nearly worthless. A premium would therefore probably be placed on creative design, art, originality—in short, on the distinctively human and creative contributions. Perhaps laziness would cease to be regarded almost as an evil.

I think that we might come to hospitalize criminals as being either curably, or else incurably, sick, rather than as being "guilty" of "evil intent" and "meriting" punishment therefor.

This scientific hospitalization penal concept could follow the general recognition that punishment often tends to fix people in unthinking and highly resentful modes of action, thus increasing the frequency of the activities that punishment is intended to diminish.

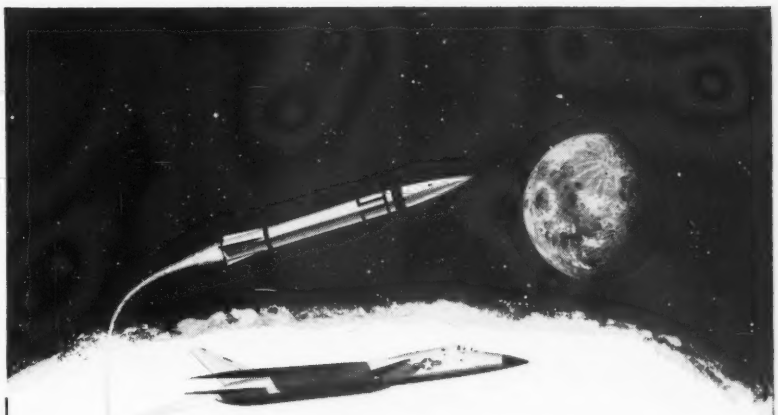
A very great danger exists today for humanity—namely, that we are all the time, and inadvertently, interfering with the biological evolution of our own species toward a more effective adaptation to our natural environment. This interference stems in large part from our recently acquired control over our environment. It also stems from our sensitivity to social suggestion—advertising, if you want to call it that—and to our social customs and taboos.

With these thoughts before us, let's now turn our attention to the character of future warfare and weapons Right now, I think, we in the U.S. badly need a strong and invulnerable deterrent weapon system. For this purpose, it seems most necessary to have a large set of retaliatory missiles, launchable from mobile, well-dispersed and well-hidden sites located outside the borders of the U.S.—perhaps in the oceans. This system should be advertised to be, and should in fact be, of the non-instant-reaction type. It should be a delayable, and measured, but inevitable, type of retaliation system, because in this way it will provide maximum deterrence against—and minimum attraction as an inviting target to—any "strike-first" gamble on the part of a potential enemy.

Civil defense is, of course, a most vital problem area. There are already strong forces in our civilization tending to disperse big city populations. Actually, a rather rapid and profitable dispersal of America's population might be caused to occur if we could analyze, and work to diminish, those forces which are presently holding people together in the very large urban areas against the natural forces already tending to disperse them.

Today, we, as a nation, are rather vulnerable to a large-scale military attack accompanied by radioactive fallout. So is Russia, and so is every other nation and continent. I believe, however, that over a period of 10 years or a little more, enough could be accomplished through the design of population shelters, and in other ways, to greatly reduce our serious national vulnerability to radioactive fallout. This reduction in our vulnerability to a large-scale attack could be very important in reducing the probability of any such attack.

We will soon have adequate numbers of deterrent-type missiles in readiness. Starting now, therefore, we



ADVANCED DESIGN

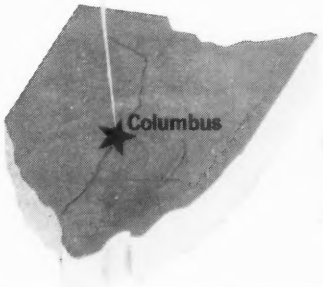
Several positions are available in the Advanced Design Section for senior engineers and scientists. Our Advanced Design Section is divided into two groups: Preliminary Design and Military Operations Analysis.

Preliminary Design engineers are responsible for both aircraft and missile configuration, performance, structures, propulsion, electronics, and support equipment. Intensive experience in any of these areas is a pre-requisite.

The Military Operations Analysis group is investigating requirements for advanced Logistic, Defense, Attack and Reconnaissance Systems. This group is responsible for being familiar with the state of the art in all military weapons areas, using this information to optimize weapon proposals.

Current studies in Advanced Design range from underwater attack detector methods to space vehicles, including VTOL-STOL, boost glide ideas, missiles of all types, ground handling and support equipment and other still confidential studies.

Engineers, Mathematicians and Physicists are invited to write for more information to Engineering Personnel, Box AS-429 North American Aviation, Inc., Columbus, Ohio.



THE COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC.

Home of the T2J Buckeye and the A3J Vigilante

For Safe Flexible Fluid Handling Lines—
specify CHIKSAN SWIVEL JOINTS

FOR MISSILE FUELING
Swivel Joints and assemblies to handle cryogenic liquids and fuels in ground loading and topping hose. Assemblies developed to handle services ranging from −320°F to +600°F and pressures from 20″ vacuum to 15,000 psi.

FOR GROUND SUPPORT EQUIPMENT
Loading arms and flexible transfer assemblies for handling Lox, N_2, He, JP Fuels, H_2O_2 and Hot Gases. Sizes range from ¼″ to 16″. Corrosion resistant steel, nickel, brass, aluminum, bronze and other metals available.

FOR GROUND HANDLING EQUIPMENT
Swivel Joints and assemblies to handle hydraulic, pneumatic, and fuel systems on launching vehicles and missile transporters. Units for rotation in 1, 2 or 3 planes in widest variety of metals, pressure and temperature available.

FOR AIRCRAFT SYSTEMS
Compact, lightweight package units in ¼″, ⅜″, ½″ and ⅝″ O.D. tubing sizes. Pressures of 28″ vacuum to 4,000 psig. Temperatures of −65°F to +275°F. AN and MS standard end connections.

CHIKSAN COMPANY
A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION
CHIKSAN COMPANY—BREA, CALIFORNIA

Send for informative Bulletin 558
59-41

should begin to turn our attention once again to the operational requirements, and the weapons requirements, of limited warfare. The latter is a technologically more difficult, multifaceted, and open field, compared to that of "deterrent" warfare and weapons, and one which will emphasize more and more the highly mobile applications of military force in a wide variety of precisely controlled and delimited situations.

I can visualize our having small groups of Marines, say, with each man fitted out with some sort of individual "flying platform." Each member of the team would be closely coordinated with his buddies, and the team would be able to move swiftly into, and immobilize enemy activity in, an area such as a town or a stretch of river or a patch of jungle, and then move out again as fast as it moved in. Their weapons might include, for instance, tear gas and other pacifying devices. Such troops might well be the forerunners of the international police force of a world government, if indeed such a government ever evolves.

Commercial sea traffic is, and will probably remain, vital to the welfare of the free world. This traffic must be protected from potential submarine attacks, and it is most difficult to find and kill submarines lurking in the ocean. A solution to this problem, then, might lie in the design of commercial ships which would run on hydrofoils, for example. In this way, they might be given speeds over fairly calm seas of about 100 mph, while producing very little noise under water, so as to avoid alerting enemy submarines to their presence. Also, such ships would provide poor targets for submarine-fired topedoes, and would have the direct economic advantage of high transport capacity.

Another possibility is to design submersible cargo vessels. Such ships could probably not move as speedily through the water as hydrofoil vehicles over calm seas and might have unusual docking problems, but they would be nearly independent of enemy submarine threats and weather and sea ice conditions during submerged operations.

I suspect certain new technological developments—a suitable, lightweight nuclear propulsion system, for example—might conceivably make the airplane into a profitable cargo transport vehicle. This could in turn do much to eliminate the threat of submarines to the commercial lifelines of the free world.

At present, the free world is critically dependent on oversea transport of fuel oil. This serious vulnerability will be reduced as each country's local sources of nuclear energy become developed.

Every modern nation greatly fears a major nuclear war. And any so-called "small" war which clearly threatens the national life of any country possessing atom bombs will almost certainly become a major war. Hence, I think that no nation can really afford to "win" any war—certainly not in the old sense of crushing all military resistance and then imposing a peace of unconditional surrender. From this viewpoint we see that the Korean and Suez conflicts were typical of the "small" and inconclusive wars of the present era. They had the advantage, at least, that they ended small.

Since every nation greatly fears any war, on the ground that it might become a major war, considerable self-discipline is now rather clearly being exercised independently by the nations of the world to prevent the occurence of any war. This, I believe, foretells that "small" wars will gradually become less and less frequent until they eventually stop completely.

With the coming of the "cold war," it has also gradually become clear that statements of national goals and national slogans can, in fact, be weapons of international struggle and conflict. In this grim game of words, we often seem at present to do less well than our opponents. No amount of technological advances will solve this crucial problem. It seems obvious, therefore, that our leaders must say not only what we stand *against*, but also what we stand *for*.

Foreign Views of America

The foreigner's views of our American civilization are often centered around the confusions appearing in our free press, our apparent material prosperities, coupled with our alleged cultural scarcities, and our confused national mores, which often appear to combine a wooly-witted generosity with a narrowly selfish "businessman's ethic." It will not be easy to erase or correct this picture of the American way of life. To do so, we cannot afford, I think, to base our national policy entirely on strong support of the status quo throughout the Western world while simultaneously urging the peoples of the East to rise in revolt against their rulers.

Instead, we must adhere to, and clearly enunciate, national goals that attract to our cause the other peoples of the world—non-Christian peoples, non-English-speaking peoples, non-industrialized peoples, nonwhite peoples. We must work toward a world in which nearly every individual will have a good deal of hope, a fair degree

of personal prosperity, and a large measure of personal freedom.

Democracy and science and technology show that such a world is indeed possible. We must adapt our business methods to serve their natural aims—the distribution of the world's goods in a plentiful measure to every individual. We must stress not a so-called "Christian" ethic, but rather a fundamental "humanist" ethic in accord with the humanitarian aspects of Christianity, Buddhism, Hinduism, Confucianism, Marxism, Judaism, and other great philosophies of human history. At the same time, all people should be encouraged and helped to keep their own customs and cultural values intact as far as possible.

The world of science is here. It cannot be denied; it cannot be forgotten. But it can be used for man's good or man's destruction in a thousand different ways. Science will look at all the possibilities. The scientist must tell what he has discovered and what the obvious implications are.

But we—every individual among us—must shoulder the responsibility for creating our future civilization, in some pattern or other, planned or unplanned, bad or good.

Auxiliary Power

(CONTINUED FROM PAGE 31)

addition of batteries for earth-shadow operation during the takeoff phase is eliminated.

As to cost, in the power range above 100 watts the cost of radioisotope power sources is very great in relation to oriented solar power converters. In the 100 watt range, however, the cost differential, which would amount to about $500,000 per auxiliary power unit, is small in relation to total mission cost, and would certainly be justified if a radioisotope power source offered a significant performance or reliability differential over a solar power source.

Each space mission will require at least three APU's—one each for flight, spare, and environmental purposes. Unfortunately, the radioisotope power sources seem to have special shielding, handling, and policy problems not associated with the solar power sources. In the power range perhaps above 1 kw, and certainly above 10 kw, the nuclear-reactor turboalternator certainly has a weight and cost advantage over solar and radioisotope power sources. But the working life of bearings in a turboalternator today is at least a factor of ten short of that needed for nuclear-driven APU's.

Performance and cost differentials are subject to change as technical developments and production methods give one and then another power source a temporary advantage. For example, mounting solar cells on aluminum foil stretched over a wire frame folded accordion style will give substantially better watts/lb performance than the current aluminum honeycomb structures, and will extend the crossover point to that of the solar-thermionic-diode or reactor-turboalternator power. Also, improved methods of fabricating photovoltaic solar cells may greatly reduce their cost.

Now let us examine in more detail the portion of the power spectrum from 30 watts to 3 kw, and consider the factors involved in selecting the optimum solar power converter.

There are five principal power converters to be considered:

1. Solar photovoltaic cell.
2. Solar collector thermionic diode.
3. Solar collector semiconductor thermoelectric converter.
4. Solar collector fuel cell converter.
5. Solar collector boiler turboalternator.

Silicon photovoltaic cells are made by gaseous diffusion of boron into silicon to create a large area (2 cm^2) p-n junction. Solar radiation photons impinging on the silicon photovoltaic cells create electron-hole pairs. The electrons flow to the n region and the holes to the p region. The electrons and holes recombine enroute to their respective junctions.

Solar Cell Utility

Silicon solar cells can be obtained today in production quantities that are 10 per cent efficient in converting solar radiation to electrical power. The solar radiation flux level at earth is 1350 watts per square meter above the atmosphere. (Solar radiation varies as a function of the square of the distance from the sun.) Solar-cell matching techniques allow modules of 9 per cent efficiency. Solar cells are brittle and must be adequately supported so that they are not damaged by the heavy vibration and aerodynamic buffeting as they are boosted out of the earth's atmosphere into space. Current design practice uses aluminum honeycomb to achieve weights of 1.0 lb/ft^2. Future folded aluminum foil structures with solar cells half as thick as at present are expected to reach 0.5 lb/ft^2.

Careful thermal design is required for solar-cell panels, as their electrical power output is halved for each 100 C rise. Spectrally selective coatings which reject ultraviolet radiation are in use today in the form of glass slides

Expanding the Frontiers of Space Technology in

FLIGHT CONTROLS

■ Flight controls offers one of the most interesting and challenging areas of work at Lockheed's Missiles and Space Division. From concept to operation, the Division is capable of performing each step in research, development, engineering and manufacture of complex systems.

Flight control programs at Lockheed include: analysis of flight data and sub-systems performance, design and packaging of flight control components, development of transistorized circuits, operation of specialized flight control test equipment and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and free gyros; accelerometers; programmers; computer assemblies; guidance control systems; circuitry; and hydraulic systems and components.

In the flight controls simulation laboratory, mathematical representations of elements in a control system are replaced one by one with actual hardware to determine acceptability of specific designs. From these studies, Lockheed obtains information which is used in further refinement and improvement of final control systems design.

ENGINEERS AND SCIENTISTS

If you are experienced in one of the above areas or in related work, we invite you to share in the future of a company that has a continual record of achievement and to make an important individual contribution to your nation's progress in space technology. Write: Research and Development Staff, Dept. H-14, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; SENTRY; MIDAS; Army KINGFISHER; Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII

ENGINEERS & SCIENTISTS

Research Opportunities

Aeronutronic, a new division of Ford Motor Company, has immediate need for qualified people to staff senior positions at its new $22 million Research Center in Newport Beach, Southern California.

The Space Technology Operation offers the highly desirable combination of new facilities and advanced equipment, located in California's finest environment for living and raising a family. Investigate these exceptionally rewarding positions now:

VEHICLE TECHNOLOGY

- Aerodynamic design and testing
- Rocket engine development
- Rocket nozzle and re-entry materials
- High temperature chemical kinetics
- Combustion and detonation theory
- Combustion thermodynamics
- High temperature structural plastics & ceramics
- Advanced structures
- Rocket vehicle systems

MISSILE DEFENSE

- Supersonic aerodynamics
- Aerothermodynamics
- High temperature heat transfer
- Space physics
- Re-entry programs

ASTRO SCIENCES

- Space electronics
- Guidance & control
- Communications
- Instrumentation
- Experimental physics
- Plasma and magneto-hydrodynamics studies

Visit Aeronutronic's exhibit booth 3822-24 at the WESCON show.

Qualified applicants are invited to send resumes and inquiries to Mr. R. W. Speich, Aeronutronic, Dept. 20, Box 451, Newport Beach, Calif.

AERONUTRONIC

a division of

FORD MOTOR COMPANY

Newport Beach

Santa Ana • Maywood, California

glued to silicon solar cells. It is expected that in the future the technology of spectrally selective filters will be extended to reject the sun's infrared radiation in the 3 to 30 micron region, while permitting far-infrared re-radiation cooling of an 85-C panel surface.

Attitude control of solar panels is being developed as a minor part of one space-probe attitude control system which points an antenna toward earth and tracks the sun and planets for space navigation. The output of the solar cells decreases as a function of the cosine of the radiation incidence angle. The additional weight required for solar-panel attitude control is only 3 to 4 lb.

Thermionic Diode

In the solar collector thermionic diode, an oriented (±1 deg) solar collector concentrates the sun's rays at the focal point of a lightweight parabolic mirror to heat the cathode of the thermionic converter. Electrons in the hot (1000–2000 C) cathode escape to the cold anode by virtue of their kinetic and potential energy, and they flow from the anode back to the cathode through an external resistance load, where they do useful work. Close spacing (0.001 in.) of the anode and cathode is required for vacuum thermionic diodes to minimize the space charge. Cesium vapor is used to create positive ions that neutralize the space charge and adjust the cathode work function.

Power densities in the range of $^1/_4$ watt/cm^2 are currently being obtained with vacuum diodes at potentials of 0.8 volts at cathode temperatures of 1000–1200 K. The thermionic diode is in its infancy, and very substantial increases in power density, operating temperatures, and life are anticipated for it during the next few years.

To provide space auxiliary power, a solar collector can concentrate the sun's rays to heat the hot junction of a semiconductor thermoelectric element. The cold junction is cooled by radiating to space. The performance capabilities of a thermoelectric converter is generally defined by its "figure of merit," which is $Z = S^2 \sigma / K$, where S = Seebeck coefficient $(180uV/C)$, σ = specific electrical conductivity in ohm^{-1} cm^{-1} and K = specific thermal conductivity in watts cm^{-1} deg^{-1}. Thermoelectric conversion efficiencies of 5–6 per cent have been achieved in 5-watt units at hot-junction temperatures of 600 C. The achievement of conversion efficiencies of 20 per cent appears to be highly probable. Thermoelectric materials have been developed that can provide extended life service at 800 C. For space power applications, it is most desirable that thermoelectric materials be developed that can provide 6000-hr life at temperatures around 1800 C.

Solar-collector regenerative fuel cells show promise for the space auxiliary power system. An electrochemical reaction between molten lithium metal and hydrogen gas generates electrical current. The reaction product, lithium hydride, passes through a separation unit so that the electrolyte is retained in the "battery." Lithium hydride absorbs heat from the hot fuel in a heat exchanger and is then thermally dissociated in a high-temperature chamber heated by a solar collector. Energy may be stored thermally or in fuel storage tanks. Satellite shadow operation is one of the most attractive applications for these cells, which may produce electrical power at 20 watts/lb in the kilowatt range. However, it is anticipated that it will be at least one, and more likely two to three years before this system is ready to produce auxiliary power in space.

The solar-boiler turboalternator is an attractive way of providing power from 3 to 30 kw. Solar-collector and turboalternator efficiencies are both high, about 70 per cent. Electrical power can be provided at 10 watts/lb with this system. However, continuous operation for 4000 hr is required for a typical Mars mission, and bearing wear may prove to be a problem at the high rotational speeds required to achieve 10 watts/lb performance.

In conclusion, the status of space-probe auxiliary power supplies might be summarized as follows:

1. Silicon photovoltaic cell—gives 5 watts/lb; appears the standard power system in the 10–500 watt range.
2. Solar thermoelectric—promising; operating temperature of 650 C now and 1100–2000 C later.
3. Solar thermionic diode—very promising from 500 watts-10 kw; $T_H = 2000$ C.
4. Solar fuel cell—promises high efficiency; much development required; satellites.
5. Solar turboalternator—very attractive above 3 kw; must attain 6000-hr bearing life.
6. Radioisotope thermoelectric or thermionic diode—attractive in 10–100 watt range; more costly than solar power; hazards.
7. Reactor thermoelectric—promising above 3 kw; future depends on materials research in 1100–2500 C range.
8. Reactor thermionic diode—very promising in 3–30 kw range $T_H =$ 2000 C; cesium plasma research prom-

ising; multiple staging later.

9. Reactor turboalternator—very attractive above 3 kw; must attain 6000-hr bearing life.

Coda: The solar- or reactor-powered thermionic diode is very possibly the space auxiliary power system of the future.

Based on a paper presented at the ARS Semi-Annual Meeting and Astronautical Exposition held June 8–12 in San Diego, Calif.

Men and Giant Rockets

(CONTINUED FROM PAGE 34)

duction. From 1940 until the formation of NASA, he was a staff member of the Naval Research Laboratory, successively as a guidance-design engineer, director of the Viking rocket development, head of the rocket development branch, and technical director of the Vanguard project. He was chairman of the ARS Space Flight Committee that proposed the utility of an earth satellite to the National Science Foundation in 1954.

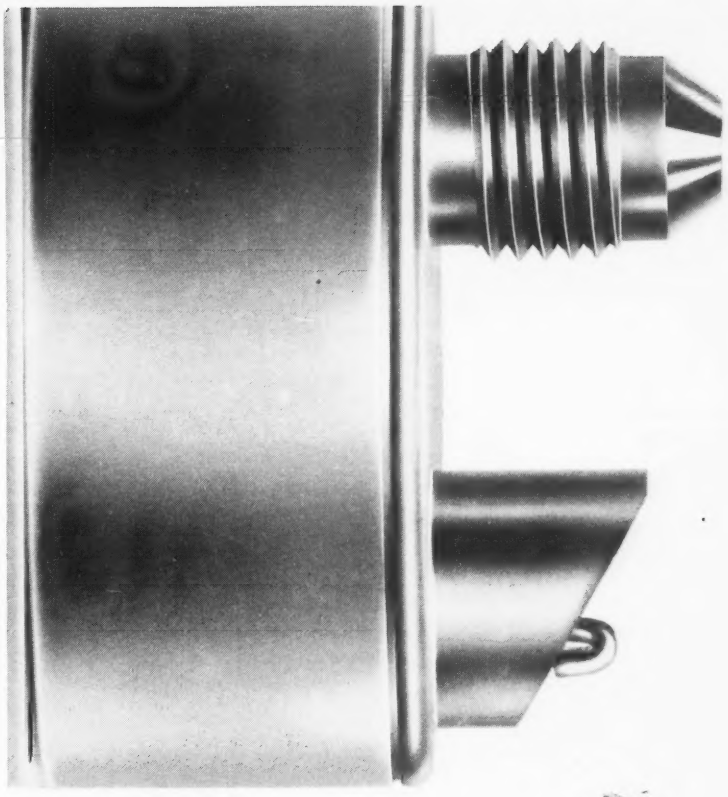
Elliot Mitchell, head of the solid-rocket development program, was chief of propulsion research and development in Navy BuOrd before joining NASA. He was chairman of the propellant working group of DOD's Research and Development Board from 1950 to 1952, and until recently was chairman of the tri-service working group in propellant propulsion.

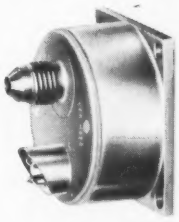
A. O. Tischler, head of the liquid-fuel rocket-engine program, came to this position from NACA's Lewis laboratory, where he had worked since 1942, and was then head of the rocket combustion section. He has specialized in combustion research, with particular emphasis on turbojet and rocket engines.

Harold B. Finger, head of the nuclear engine program, previously was head of the nuclear radiation shielding group at NACA's Lewis laboratory. He joined Lewis in 1944 as an aeronautical engineer, and specialized in research on turbomachinery, nuclear rockets, and shielding.

William C. Cooley, head of the space propulsion and auxiliary power unit program, was previously a research scientist and design engineer with North American Aviation, GE, and various govenmental groups. He contributed to the early planning and design stages of the Rover program when with North American.

The future history of rocketry will flow through the offices of these men. An attentive audience awaits the reading of that history.





new Bourns absolute pressure transducer

Miniature potentiometer transducer/ 35G vibration, 20-2000 cps/ High accuracy/ 5-ounce weight

New bourdon tube instrument for telemetering and control of missile, pneumatic, and hydraulic systems. Absolute, gage, or differential pressure ranges available with static error band of ±0.9%. Excellent noise-free low error performance in high vibration and acceleration environments.

Model	725
Pressure ranges	up to 0-5000 psia
Static error band*	±0.9%
Dynamic error band (includes ±35G to 2000 cps)	±1.8%
Discontinuities (noise)	None
Size (exclusive of fittings)	1-¾" D x ⅞"

*Includes friction, hysteresis, linearity, resolution, repeatability

Write for complete technical data

BOURNS, Inc.
P.O. Box 2112 J, Riverside, Calif.
Field Engineering Offices:
L. I., New York, and Dallas, Texas

Pioneers in potentiometer transducers for position, pressure and acceleration.

Exclusive manufacturers of Trimpot®, Trimit®

In print

Rocket Propellants by Francis A. Warren, Reinhold Publishing Corp., New York, 1958, 218 pp., illus. ($6.50)

This book is a satisfying review of the information that can be published in declassified form in regard to rocket propellants, both solid and liquid. The author goes further than a discussion of propellants; the book also covers the relationship between propellant and the operational characteristics and requirements of rockets.

In addition to the chapters on propellants, which include systems, ingredients, manufacturing and processing, and combustion mechanisms, the book also treats of the interaction between combustion enthalpy, working fluid, and the expansion process. It also contains a chapter on ignition, and a very good introduction to the problems of utilizing propellants in rocket engine systems, including even such items as methods for attainment of thrust vector control.

The chapter on safety is brief, but excellent. It should serve as sufficient warning to those who would conduct amateur experiment without adequate equipment and safety precautions. There is also a good introduction to the problems attendant to quality control and testing of rockets.

Only a few errors were detected, perhaps the most glaring being the value for the heat of combustion of analine, given in Btu's per pound in the table appearing on page 21. This is particularly deceptive, since it appears that analine has a higher heat of combustion than such exotic fuels as decaborane. In an attempt to track down the source of this error, it was found that the value is apparently stated in Btu's per kilogram; the reader can correct it by dividing by 2.2. Equation 21 in Chapter 4 is correct, but one might disagree with the preceding statements used for its derivation, since the author fails to recognize that momentum change in the exhaust jet is associated with unbalanced pressure forces inside the rocket chamber.

The discussion of the internal burning solid propellant charge appearing on pages 137 and 138 is misleading in that it implies that all such devices are inherently progressive; that is, they undergo an increase in surface area during burning. Numerous designs are inherently neutral, maintaining a constancy of burning surface within less than 0.1 per cent.

The chapter on the future of propellants is stimulating, even though the sophisticated reader may disagree with some of the statements.

This book is highly recommended for those who desire a general introduction to the field of rocket propellants and their utilization in rocket engines. It can also be a handy reference for the more thoroughly initiated, since it provides very convenient access to many fundamental equations and items of data. The book is definitely not a "do-it-yourself" manual, nor does the author intend it to be such. In the introduction the author states: "This book has been written with the sincere endeavor to present to the reader a picture of the field of propellants. . . . No atempt has been made to go into such details that the reader will immediately be able to start designing his own rocket or missile."

In the opinion of this reviewer, the author has accomplished his purpose.

—Harold W. Ritchey
Thiokol Chemical Corp.

BOOK NOTES

The Pirotechnia of Vannoccio Birenguccio (477 pages, Basic Books Inc., New York, $8.50) was the first printed history of metallurgy written by a western man of learning, wide practical experience, and modern spirit. Issued in translation in 1942 in a limited edition, the "Pirotechnia" has been reissued in handsome form in response to many requests. Not just part of the history of technology, the "Pirotechnia" gives insight into the age and the kind of man who revived investigation of the nature of life. A contemporary of Benvenutio Cellini, Birenguccio became an engineer, foundryman, metallurgist, and man of letters. He held the authority of classical learning in no special favor, and brought to bear his powers of observation and experiment to codify and add to the high metallurgical art of the renaissance. And in the scientific spirit of conversation and exchange, he wrote and published the sum of his experience and learning. This can be recommended as reading in our culture for the specialist and layman alike.

Space Primer (72 pages, Convair Div. of General Dynamics Corp., San Diego, Calif.) takes up the basic concepts and methods of rocketry and space flight in seven brief, clearly written chapters: Origins of Astronautics, The Rocket, Escape from Earth, Propulsion, The Motion of Bodies in Space, Satellites, and To the Moon and Planets. A chapter on careers in astronautics, a glossary, a very good bibliography, and a number of diagrammatic illustrations complete the neat billfold-size booklet. It would be hard to beat this jim-dandy primer for helping to explain astronautics to anyone without an education in science—office and shop staffs, the youngster, wife, or old pal who took to English literature. The booklet can be obtained from Department 120-70, Convair-Astronautics, P.I. Box 1128, San Diego, Calif., at a cost of 10 cents each for up to 3000 copies, with lower prices for more.

Space Guide, edited by Vincent F. Callahan Jr. (174 pages, Washington Space Letter, 1420 New York Ave. N.W., Washington 5, D.C., $10), written in brisk nontechnical language, surveys the beginnings, organization, staff, programs, and facilities of the National Aeronautics and Space Administration as of the end of 1958. As its subtitle says, this handy volume is a basic guide to NASA, bringing together the variety of information a businessman would like to know about our national space agency—the documents establishing NASA, the official list of services, supplies, and equipment purchased by NASA on a competitive basis, patent provisions of the space act, a NASA telephone directory, readable biographies of key NASA personages, summary organization charts with names, and so forth, as well as the larger aspects of NASA's structure, projects, and working groups and procedures. "Space Guide" admirably achieves its main purpose—to provide a ready, concise introduction to NASA and its contracting activities.

RECEIVED

U.S. Aircraft, Missiles, and Space Craft (152 pages, National Aviation Education Council, 1025 Connecticut Ave. N. W., Washington 6, D.C., $1.00). Magazine format, paperbound.

The Book of Missiles by Clive E. Davis (96 pages, Dodd, Mead & Co., New York, $2.75) Brief, popular descriptions with photos.

The Aircraft Year Book, 40th Annual Edition, 1959 (486 pages, American Aviation Publications, Inc., 1001 Vermont Ave. N. W., Washington 5, D. C., $6.00).

Everyday Meteorology by A. Austin Miller and M. Parry (270 pages, Philosophical Library, New York, $7.50).

1001 Questions Answered About the New Science by David O. Woodbury (358 pages, Dodd, Mead & Co., New York, $6.00). Or, how to start an argument.

GPL research

Nuclear Gyros

GPL research is now studying for the U. S. Air Force, the feasibility of harnessing the most efficient gyro known to science—the nucleus of the atom. Development of such a gyro—tremendously accurate, perfectly balanced, friction and maintenance free—will revolutionize space reference, navigation and guidance techniques.

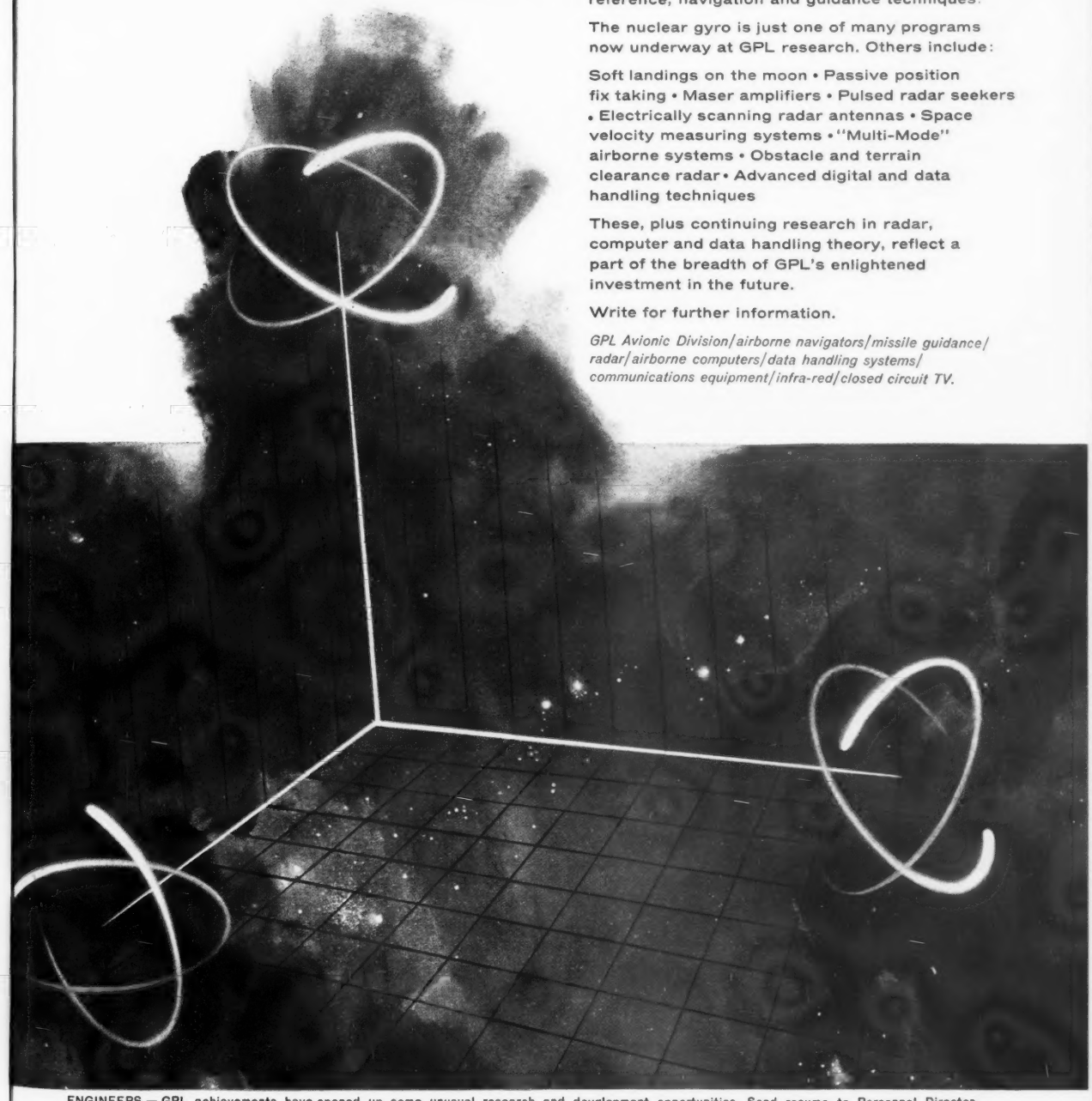
The nuclear gyro is just one of many programs now underway at GPL research. Others include:

Soft landings on the moon • Passive position fix taking • Maser amplifiers • Pulsed radar seekers • Electrically scanning radar antennas • Space velocity measuring systems • "Multi-Mode" airborne systems • Obstacle and terrain clearance radar • Advanced digital and data handling techniques

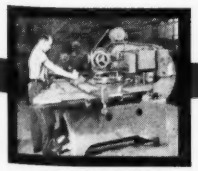
These, plus continuing research in radar, computer and data handling theory, reflect a part of the breadth of GPL's enlightened investment in the future.

Write for further information.

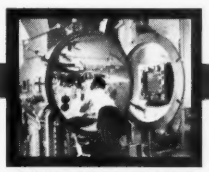
GPL Avionic Division/airborne navigators/missile guidance/ radar/airborne computers/data handling systems/ communications equipment/infra-red/closed circuit TV.



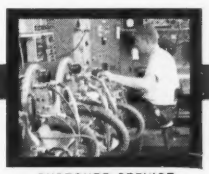
ENGINEERS — GPL achievements have opened up some unusual research and development opportunities. Send resume to Personnel Director.



MANUFACTURING



ENVIRONMENTAL TESTING



CUSTOMER SERVICE

RESEARCH / ENGINEERING / FLIGHT TESTING

GPL

A GENERAL PRECISION COMPANY

GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N. Y.

A Subsidiary of General Precision Equipment Corporation

Missile market

BY JEROME M. PUSTILNIK, Financial Editor

SURGING ahead and recovering all the ground it had lost earlier, the stock market was in a position as July began to challenge its old highs.

Although the Dow-Jones Industrials at 644 were unchanged from the previous month's close, they actually rebounded almost twenty points from their lows. Missile shares, conspicuously weak during most of the month, also ended the period with a vigorous rally. Nonetheless, the Missile Index still showed a 2 per cent loss for the month, reflecting the substantial price correction in these securities.

A study of the index reveals that only a few missile stocks withstood this trend. Ryan Aeronautical and General Precision Equipment were moderately higher, while Litton and Raytheon, each of which had suffered severe reaction earlier, recorded good gains. Among aircrafts, the erosion of share prices continued for almost all companies. Some, like Douglas and General Dynamics, haven't sold this low in almost two years. (If investors have foresaken the aircrafts, at least two worthwhile opportunities are being overlooked. Martin and Northrup seem especially attractive, and they will be discussed here in a coming issue.

Many investors may wonder whether the outlook for missile companies has become less favorable. The downward drift of missile share prices during the past two months might seem to support this idea. A price correction, however, is not unusual after the prolonged rise many missile issues have enjoyed. At its current closing level of 1071, the missile Index was 67.9% above a year ago, compared with a 35.7% rise for the Dow. When the Index set its high in May 1959, closing at 1128, it was up 13.2% for the month, and a rousing 91.9% for the year.

Outstanding market performance of this kind attracts attention—and speculators, who, following price action solely, are interested in short-term trading profits rather than the gratifying results which can reward a successful long-term investment holding. As prices of missile issues began to decline (and it would be unreasonable to expect them to appreciate at the rate of 13.2% each month), traders and speculators sold out these stocks to cut their losses short. Just as they did not inquire into the merits of missile securities before purchasing them, they did not consider their long-range investment outlook before selling. This trading activity, unsettling as it may be in either direction, has no bearing whatever on the investment outlook for missile companies.

This column continues to be enthusiastic over the long-term investment potentials of our industry.

THE MARKET AT A GLANCE

*Index compiled June, 1955

	July 1959	June 1959	% Change	June 1958	% Change
Dow-Jones Industrials	644	644	—	475	+35.7
Missile Index	1071	1093	−2.0	638	+67.9

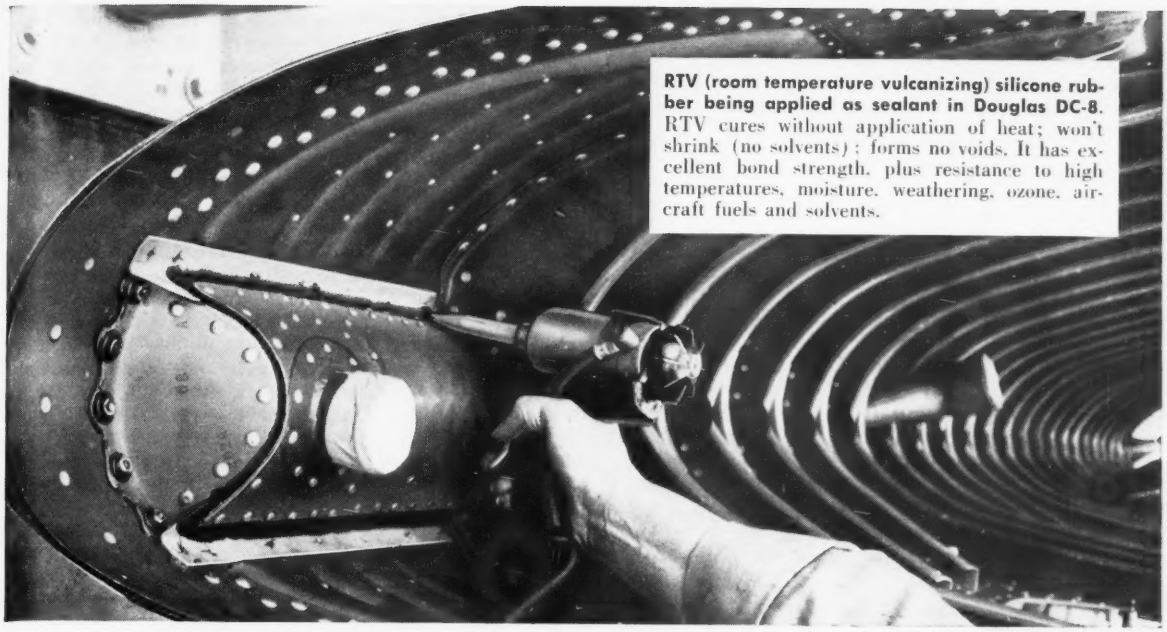
ASTRO Covers Available

In response to a number of requests, ASTRONAUTICS is offering full-color reprints of its covers, beginning with the May 1959 issue. Reprints will be in the form of laminated plastic display plaques, with a metal D-ring on the back for easy mounting on a wall. The full-size cover, with a suitable mat, is mounted on 1/4-in. rigid hardboard, with beveled edges, and over-laminated with transparent vinyl plastic. Size of the plaque is 11 by 12 in. Cost is $2.00, and only a ***limited supply*** of covers will be available each month.

The plaques may be obtained by writing to ASTRONAUTICS, 500 Fifth Ave., New York 36, N.Y.

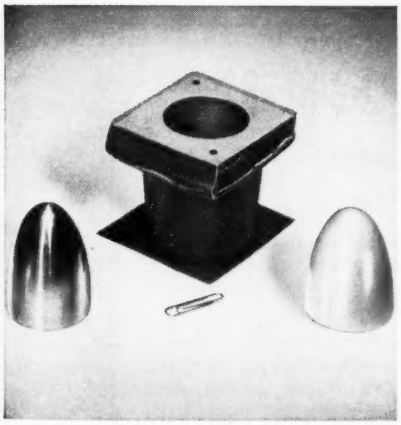
Mail by Missile

A Regulus I missile, launched from the U.S. submarine Barbero 100 miles at sea, delivered 3000 letters to Mayport Auxiliary Naval Air Station near Jacksonville, Fla. Postmaster General Summerfield, who witnessed the event, termed it "the first known official use of missiles by any post office department of any nation," and predicted that mail will be delivered intercontinentally by guided missile before man reaches the moon.

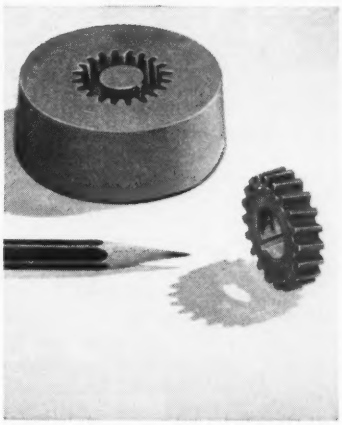


RTV (room temperature vulcanizing) silicone rubber being applied as sealant in Douglas DC-8. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

G-E RTV silicone rubber—a superior material for tooling, encapsulating and sealing



Prototype jet engine nose cone (right) cast in RTV mold. Epoxy parts cast in flexible RTV molds have a bright, glossy surface and reproduce extremely fine detail. No parting agent is required for even the most complex parts. High tensile and tear strength is retained even after prolonged heat aging.



Close-tolerance, non-standard helix gear cast complete in low-cost, one-piece RTV mold. Previously such replacement parts had to be machined by hand. Now they can be quickly and inexpensively replaced by using the broken part as a master.

Potting and encapsulating of electrical components, such as this aircraft transformer, are easy with RTV. It can be poured, sprayed, painted or applied by dipping. Temperature resistant from −60°F to +600°F; excellent resistance to high altitude arc-over and corona. Comes in wide viscosity range.

For application data and samples of General Electric RTV silicone rubber, write to General Electric Company, Silicone Products Department, Section V82, Waterford, N. Y.

GENERAL ELECTRIC

Silicone Products Dept., Waterford, N. Y.

Testing a Titan

(CONTINUED FROM PAGE 28)

pellants are run through the setup under flight pressures and conditions. The only difference from the real thing is the lack of an engine at the business end.

The rocket engines for both Titan stages are made by Aerojet-General and static-fired for acceptance by the Air Force at Sacramento, Calif., then shipped to Denver. At Denver, incoming engines are tested using the actual GSE which will support them in field operational use. The hydraulic, electronic, electrical, instrumentation, and plumbing systems are checked; a Sanborn Recorder Trace is used for testing all valve opening and closing times; and the "continuity" of the engine's intake system is checked using first pneumatic pressure and then RP-1 and liquid nitrogen.

When each component or subsystem has passed all its tests, it goes to the factory, accompanied by its complete manufacturing and test history, to be "spliced" into a missile.

The missile stages are then placed on transtainers, which will stay with the Titan until it is erected on the launch pad. Then the missile goes "up the hill" and into a 13-story building, the Vertical Test Fixture, which has no known parallel in missilery.

Inside the VTF, the Titan stage on its transtainer is drawn into a center aisle, flanked on both sides by a series of Titan-sized test cells. An overhead crane picks up the missile and places it vertically in a cell. For the first time, the Titan stands up, in its takeoff position.

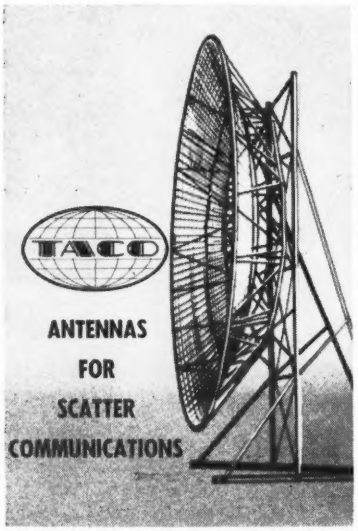
A clamshell gantry, providing working levels, closes around the Titan in the cell and the cell doors are closed. The VTF has seven such cells, with working gantries and closing doors, and two open cells, lacking gantry and doors but equipped with steel members for placing one or both Titan stages in any desired position. These two open cells are used for structural and destruction tests.

Open-Cell Tests

In the open cells, Titan is subjected to all flight conditions simultaneously. It is stress-loaded with steel cables, and side jacks are applied to simulate the weight, thrust, and airstream of flight. The tanks are loaded with liquid nitrogen at −300 F and drained at flight rates during testing. A huge sleeve of high-wattage quartz lamps is wrapped around the missile to simulate aerodynamic heating. Everything is applied at once, with certain conditions varying continuously, simulating changing conditions of flight and the varying attitudes of the missile as it rolls, pitches, and yaws. The body of data gained from the test is a highly accurate prediction of actual flight behavior.

In two of the closed cells, tests are run on the Titan's hydraulics and associated systems, gathering specific and complete information for structural analyses and design. In another closed cell, the missile is loaded with simulated propellants—water and liquid nitrogen—for structural feedback studies. In this cell, electrical and electronic systems are measured for feedback, along with the stresses and strains that flight will apply on the black boxes of the system's hardware. To eliminate any extraneous variable factors, each of the closed cells is shielded against radio-electronic interference, so that test readings are done under conditions of maximum attenuation.

In the remaining four closed cells, Titan undergoes the most exhaustive physical examination known to have been made on a major missile. The gantry levels close around the bird, forming a stack of closed rooms with the missile in the middle. Then 50 men begin hooking up nearly 500 sensor points, which will give readings on every flick and nuance in the missile. This equipment is a complete set of



Parabolic reflectors up to 32' diameters, complete with feed systems to meet specific needs, including dual polarization. Taco is one of the world's largest suppliers of parabolic antennas to the military and commercial markets.

Write for complete technical data...

TACO

TECHNICAL APPLIANCE CORPORATION
SHERBURNE, NEW YORK

RESEARCH ENGINEERS

Explosives

ARMOUR RESEARCH FOUNDATION has a limited number of positions open in explosives research for individuals with imagination and ingenuity. This is an opportunity to work in small project groups.

Projects are in the areas of Sensitivity Output, Warhead Design and Evaluation, Fuzes, and Explosives Forming Techniques. Men with degrees in Physics, Mechanical Engineering, or Electrical Engineering and an interest or experience in this field are invited to apply.

Excellent employee benefits including liberal vacation plan and tuition free graduate study. Please send resume to:

E. P. Bloch

ARMOUR RESEARCH FOUNDATION

of

Illinois Institute of Technology
10 West 35th Street
Chicago 16, Illinois

GSE, functionally identical to the gear used at operational Titan complexes (differing only in the length of the cables). The only equipments not included are propellant-loading and engine-ignition systems.

The equipment is spread over six levels, or bays, in each cell. The top bay, around the Titan's nose, is the guidance bay. Here tests are run on the flight control, guidance, and range safety system. The fifth bay is for telemetry, additional safety testing, and the power-output units. Roughly 300 measurements are read out in this bay. The fourth bay is for checking both hydraulic and electrical power, and is headquarters for conducting the simulated countdown that is a part of the vertical test. Around the top of the first stage is the third bay, where the testing signals are simulated and checked. On the lowest level, the "boiler room," is the first-stage rocket engine and the scene of tests for the hydraulic and pressurization controls. The main engine is under slight but constant internal pressure—applied by a GSE console—to prevent it from becoming contaminated with any form of dirt.

An incoming Titan is first erected in the VTF cell. Then the electrical busses are checked for ground loops and other minor ailments, followed by a check of tankage and pressure systems, including all valves, regulators, indicators, and individual working parts.

Next every component in the propulsion system is checked, short of actual loading and ignition. The control system gets the next close look, using blockhouse GSE, and including input-output, hydraulics, servomechanisms, internal missile programing, and all associated functions.

Then the guidance system is married to the Titan. Missile telemetry is tested next, during which the missile's antennae actually transmit to ground-station receivers. Then a timed countdown is run, simulating all the functions of the Titan, including engine operation, and the reactions are logged.

After the countdown, data constituting a detailed pedigree of the bird are reviewed by a team of representatives from the Air Force and the Titan associate contractors. If a Titan passes the evaluation, it is bought by the Air Force at this point.

The missile then goes to "the top of the hill," the captive test stand, its last stop at Denver. It is accompanied up the hill by one log containing a history of every component and a second log on the missile as a whole.

The captive-test stand differs from the operational Titan launch pad in one detail only—there are no explosive bolts in the stand to release the missile for flight. Launching crews are first trained on the captive-test stand.

In addition to the Missile Compatibility Firing, or final static-test firing of flight Titans, the hill stands run two other basic types of tests: Battleship and captive-missile tests. In a captive test, a missile is subjected to both specified and extreme conditions, and the data run as feedback in preparing flight birds.

Battleship tests are so called because of the heavy steel-girdered tanks used instead of the usual propellant tanks. With these tanks, propellant and propulsion tests can be run without pressure-safety problems. These tests evaluate the capability of the propulsion system and a major part of the flight control, hydraulic servo, and supporting GSE systems. Like the captive tests, they are first run normally, then the parameters are explored. Firing of both stages in flight sequence has been tested with battleship tanks.

Each lot, or group, of Titan's has a test plan (TP), which is a set of general lot-test directions as compiled by all Titan personnel concerned. The TP is written into the General Countdown. The General Countdown, containing a checklist for the MCF, is the final test document at Denver.

The MCF, complete but for liftoff, yields roughly 225 major measurements and separate bodies of test data. Eight hours after an MCF, quick-look data is available, but the men in the blockhouse usually know what happened before the road blocks are up.

When the MCF is completed, the missile is as ready for flight as it can be made. The Titan stages on their transtainers are trucked 15 miles to Lowry AFB for airlift to Cape Canaveral. The thoroughness of the testing and preparation in the Denver laboratory environment, and the speed of the airlift, mean that very little must be done at the Cape facility outside of the launch itself.

Government Research Reports Available

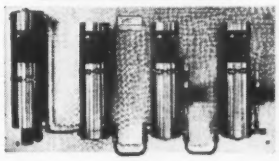
An OTS monthly listing of unclassified reports issued by the AEC, the military services, and other government agencies can be obtained from the Supt. of Documents, U.S.G.P.O., Washington 25, D.C., for $6.00 a year. Also, OTS currently offers a cumulative listing of some 4000 unclassified AEC reports free of charge. A report of research highlights in National Bureau of Standards programs for 1958 is available from the G.P.O. Supt. of Documents for 45 cents.

LEAK PROOF VALVES . . .
Replaceable Soft Seat
Metering or Flow

HI-VACUUM TO 6,000 PSI
PNEUMATIC HYDRAULIC
ANGLE—GLOBE—THREE PORT—MANIFOLD

ROBBINS Aviation, Inc.
2350 E. 38th St.—Los Angeles 58, Calif.

DEHYDRATION



Remove moisture & oil vapor from gases with working pressures up to 12,000 PSI; dew points - 100°F.

GET CLEAR WWV SIGNALS

The Mosley ST-3 multi-frequency beam antenna is peak-tuned to U. S. Bureau of Standards radio station WWV at 10, 15 and 20 mc. The ST-3 helps you receive consistently-clear WWV signals anywhere in the world.

Write for data and specifications.

MOSLEY ELECTRONICS, INC.
St. Louis 14, Missouri

*Specialists in high-frequency and VHF communication arrays...rotatable and vertical.

Inquiries answered promptly.

International scene

BY ANDREW G. HALEY

The Japanese Rocket Society's International Symposium held in Tokyo May 25-28 proved a most interesting forerunner to the Commonwealth Spaceflight Symposium which will be held in London just prior to the 10th Annual Congress of the International Astronautical Federation. More than sixty papers were submitted, including those by American scientists E. W. Wahl, who discussed the problems of determining orbital elements and of issuing predictions for earth satellites; Robert E. Roberson, who submitted a paper on gyroscopic control of satellite attitude and, while delineating achievements to date, also indicated the areas where further analysis is required, and J. L. Armstrong, who gave a report on the Rover and Snap nuclear-energy rocket proposals.

Among the participating Japanese scientists, T. Murata announced that he has succeeded in making a new type of solid propellant using an active liquid reagent and ammonium perchlorate. Many other papers were presented on solid-propellant development work, a field in which the Japanese have been quite active.

The Symposium was universal in scope, with excellent papers also contributed in the fields of high-altitude investigations, magnetofluidynamics, gasdynamics, aerodynamics, human capabilities, telemetry, space communications, cosmic ray investigations, nuclear investigations, and reports on such positive achievements as the Kappa rocket project—the Japanese IGY, high-altitude, two-stage, solid-propellant sounding rocket.

The Japanese Rocket Society has a very distinguished board of directors, including four professors of the faculty of Tokyo Univ. and high officials in the telecommunications, television, chemical, aeronautical, and heavy industries of Japan, as well as public-affairs and economics experts.

° ° °

The viewpoints of members and officials of the AMERICAN ROCKET SOCIETY, as expressed in numerous publications issued not only by the Society itself but also by the IAF, found complete acceptance in the report of the Legal Committee of the United Nations *Ad Hoc* Committee on the Peaceful Uses of Outer Space. As a matter of fact, the program adopted by the Legal Committee parallels the presentations made at the ARS Space Law and Sociology Conference held March 20 in New York.

Subjects discussed at the ARS meeting on March 20 are included in the titles of the UN Legal Committee Report on legal problems susceptible of priority treatment, as, for example, the question of freedom of outer space for exploration and use; liability for injury or damage caused by space vehicles; allocation of radio frequencies; avoidance of interference between space vehicles and aircraft; identification and registration of space vehicles and coordination of launchings; re-entry and landing of space vehicles.

Secondary legal problems were also listed: The question of determining where outer space begins; protection of public health and safety; safeguards against contamination of outer space or from outer space; questions relating to exploration of celestial bodies; and avoidance of interference among space vehicles.

° ° °

The IAF has also achieved recognition in the Proceedings of the Technical Committee of the UN *Ad Hoc* Committee. Such recognition was unanimous. In the official proceedings, the IAF was listed as a cooperating international organization. This recognition was achieved through the efforts of Prof. Teofilo M. Tabanera, Honorary President of the Asociacion Argentina Interplanetaria, representing Argentina; and Col. Franco Fiorio, representing Italy; and with the assistance of the Secretariat and members of the AMERICAN ROCKET SOCIETY.

Soviet Exhibit Comes to the U.S.

Highlights of Soviet Cultural and Scientific Exhibition underway in New York's Coliseum are replicas of Mechta's final stage and Sputniks.

Computer, Glass Laminates Literature Available

Catalogs of all reports on computers and glass laminates available to the public from the collection of the Office of Technical Services, Dept. of Commerce, can be obtained for 10 cents each from OTS.

Environmental Engineers Consolidate

At the third annual meeting of the Institute of Environmental Engineers, held in Chicago this spring, the IEE and a similar group, the Society of Environmental Engineers, voted to merge under the title of Institute of Environmental Sciences. President of the new organization is Harold C. Jones of Westinghouse Air Arm Div., Baltimore, Md. The meeting drew 500.

212 L EXPEDITE

ENGINEERS • SCIENTISTS

General Electric's Heavy Military Electronics Dept.

AWARDED CONTRACT FOR

Systems Integration, Engineering, and Management of...

AIR WEAPONS CONTROL SYSTEM 212L

A universal electronic control system to meet the vast problem of Air Defense outside of the Continental United States

Systems-oriented engineers and scientists will appreciate the broadband technical challenge of the Air Weapons Control System 212L. There are important openings for men who are experienced in: Weapons Systems Analysis • Mathematical Analysis of Engineering Problems • Computer Programming • Military Communication Systems • Radar Systems • Weapons Control Systems • Electronic Circuitry • Industrial & Military Psychology.

● Working in close cooperation with the USAF, it is Heavy Military's responsibility to integrate all subsystems—data acquisition, communications, data processing and display—plus various defensive weapons into a well coordinated and efficient operating system.

VERSATILE AIR CONTROL APPLICATIONS The revolutionary 212L can be used to defend a single airfield, or, by linking control sites together, it could be used in a limited action to provide air control for an area the size of Alaska. Similarly, by linking the capabilities of countries together, a system could be provided for the air control of an entire continent. Designed for *both* fixed and mobile applications, the 212L will be used primarily outside the U. S. since the SAGE system is used for the defense of this country.

HMED IS ALSO DESIGNING THE "HEART" OF THE SYSTEM

In addition to its prime mission of providing systems management, HMED will design, develop and produce the data processing and display subsystem which is the "heart" of the 212L. Capable of rapidly and automatically detecting and tracking air targets, the subsystem operates without human assistance, except under unusual circumstances.

OTHER FAR-RANGING PROGRAMS AT HEAVY MILITARY

At the present time additional far-ranging programs are being pursued in diverse and important areas at HMED:

- Fixed & Mobile Radar
- Shipborne Radar
- Underwater Detection Systems
- Missile Guidance
- Data Handling Systems
- Communications

Individuals with experience in systems analysis or specific equipment design in the areas listed above are invited to forward their resume in complete confidence to Mr. George Callender, Div. 11-MH.

HEAVY MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

Court Street Syracuse, N. Y.

Government contract awards

$15 Million Minuteman Job Awarded to Hercules Powder

The Air Force has awarded a $15,326,000 contract to Hercules Powder Co. for research and development of a third-stage engine for the solid-fuel Minuteman ICBM. Hercules has been conducting work on Minuteman under an earlier letter contract.

Polaris Communications

A prime contract for development of communications systems for the Navy's Polaris program has been awarded to Sylvania Electric Products by the Navy's Bureau of Ships.

Vega Equipment

JPL has awarded Hallamore Electronics a $500,000 contract for Vega airborne computers and associated test equipment.

Plasma Engine Research

Republic Aviation has received contracts totaling $193,000 from ONR and AFOSR for experimentation in two major areas of development of a magnetic pinch plasma engine. The contract extends into 1960, and the company expects that a production model can be effected by 1964. A second contract, awarded by the AF in the amount of $345,000, is for development of a high-temperature hydraulic control system.

Mercury Control Center

NASA has let a $46,356 contract to Space Electronics Corp. for a study of the requirements for the control center for Project Mercury, and the specification of its equipment.

Solid Fuel Research

Navy BuOrd has awarded Metal Hydrides Inc. a $90,000 classified research contract on solid propellant fuels.

Solar Flare Emission Study

NSF has made a $250,000 grant to NRL for rocket observations of ultraviolet and X-ray emissions from solar flares.

SYNOPSIS OF AWARDS

The following synopsis of government contract awards lists formally advertised and negotiated unclassified contracts in excess of $25,000 for each Air Force, Army, Navy contracting office:

AIR FORCE

AF Cambridge Research Center, ARDC, USAF, Laurence, G. Hanscom Field, Bedford, Mass.

Research and design study for the development of a rocket engine similar in design to the XM-19El recruit, $36,098, **Thiokol Chemical,** Elkton Div., Elkton, Md.

Tracking of artificial earth satellites using a Baker-Nunn satellite tracking camera, $60,260, Univ. of California, Berkeley, Calif.

Study of high-altitude explosion flows, $34,977 MIT, Cambridge, Mass.

Study of the effect of environmental conditions on antennas for hypersonic vehicles, $63,360, **Stanford Research Institute,** Menlo Park, Calif.

Research for high-temperature switching devices, $69,349, **Philco Corp.,** 4700 Wissahickon Ave., Philadelphia, Pa.

Development of accelerometer for satellite density measurements, $74,900, **Cooper Develoment Corp.,** 2626 South Peck Rd., Monrovia, Calif.

Study of electron and ion beams under outer space conditions, $34,540, **Research Technology Associates,** 19 Jones Rd., Waltham, Mass.

An evaluation of the accuracy of space track predictions, $66,716, **Aeronutronic Systems,** 1234 Air Way, Glendale, Calif.

Study of rocket measurements of aerodnamic quantities, $53,500, **Univ. of Michigan,** Ann Arbor, Mich.

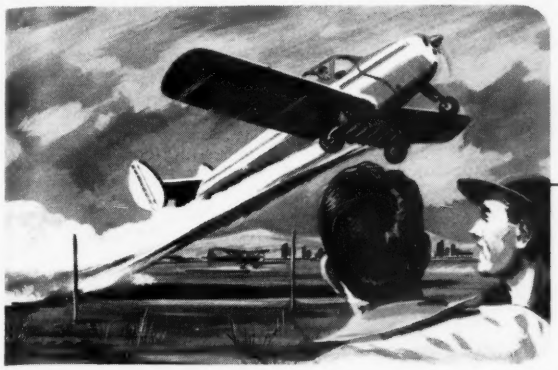
Design, development, and construction of meteoritic microphone detectors of various sensitivities for use in satellites, $31,187, **Oklahoma State Univ. of Agriculture and Applied Science,** Research Foundation, Stillwater, Okla.

Investigation of the current flow in

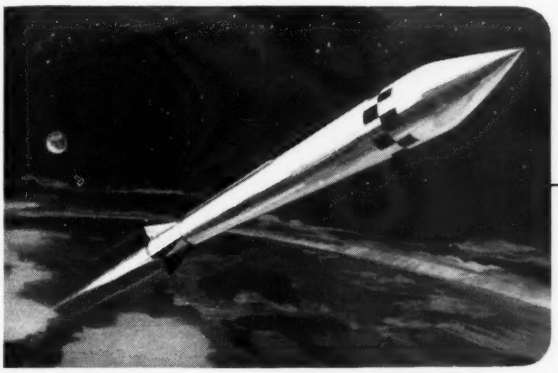
NASA CONTRACTS FOR MAY

Contractor	Obligation	Program
Aerojet-General	$ 660,000	20 Aerobee-Junior and Aerobee-Hi sounding rockets.
AF Ballistic Missile Div.	$4,400,000	Additional funds toward firing of Thor-Able and Atlas-Able vehicles.
ABMA	$1,000,000	Advanced research into (1) propulsion and propellants, (2) guidance studies involving celestial mechanics of trajectories in lunar and interplanetary missions, (3) thermal properties of materials in space re-entry research, (4) effects of space environment on physical and chemical properties.
Army Ordnance	$ 50,000	For part of 20 Nike-Asp sounding rockets to be fired at Ft. Churchill, Canada, and Wallops Island.
AOMC	$ 560,000	For multifrequency radio beacons for earth satellites investigations of ionosphere.
CalTech	$ 110,000	Basic studies of cylindrical and conical shells.
Convair-Astronautics	$7,500,000	Initial funding for 8 two-stage Vega boosters, plus additional Vega for captive firing tests.
JPL	$5,000,000	Initial funding for technical supervision of Vega project, planning Vega interplanetary missions, and providing a third stage for Vega.
JPL	$ 300,000	R&D on improved tracing and receiving equipment for deep-space missions.
JPL	$ 110,000	For transmitter to be installed in Goldstone, Calif., tracking installation as part of NASA's passive communications satellite project.
MIT	$ 200,000	Assist NASA in making technical evaluations for facilities and instrumentation in Project Mercury tracking network.
NAS	$ 350,000	Research associateship program providing study grants at graduate and post-doctorate levels at Goddard Space Flight Center.
NSF	$ 110,000	In support of Space Science Board of NAS.
Navy BuOrd	$ 180,000	16 third-stage Delta rocket motors.
New York Univ.	$ 120,000	Study of general instability of stiffened circular cylinders.
Office of the Army Surgeon General	$ 150,000	Medical aspects for successful Jupiter shot carrying monkeys Able and Baker.
Univ. of Florida	$ 60,000	Study of general instability of cylindrical shells, aimed at aiding both rocket and space vehicle designers.
Univ. of Wisconsin	$ 60,000	Design studies for ultraviolet system to go into future orbiting space observatory.
Yale Univ.	$ 110,000	To finance use of radio telescope to measure Doppler effect of the 21-cm hydrogen line resulting from earth's orbit around sun.

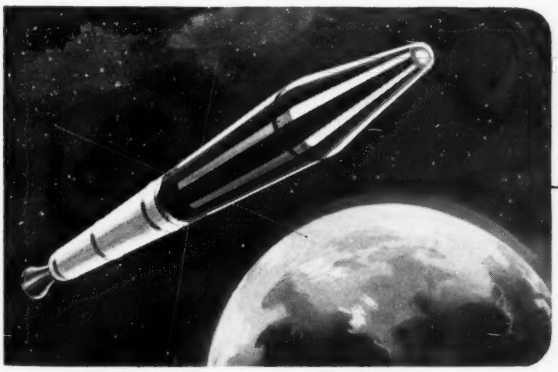
Historical Achievements at JPL



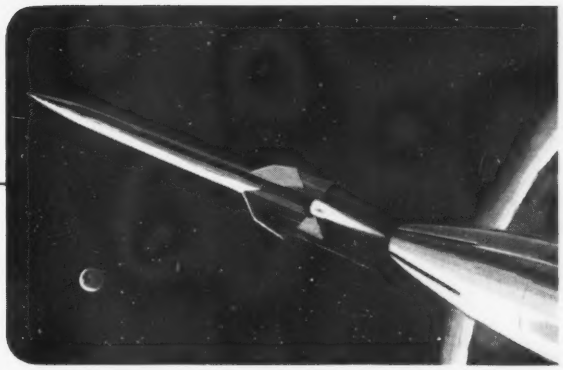
JATO UNITS... The nation's first successful jet-assisted takeoff (JATO) units were originated and developed in 1941 at the Jet Propulsion Laboratory, and sparked the development of future rocket vehicles.



THE CORPORAL... this country's first ballistic surface-to-surface guided missile, now an operational weapon of the U.S. Army, was pioneered and developed by the Jet Propulsion Laboratory.

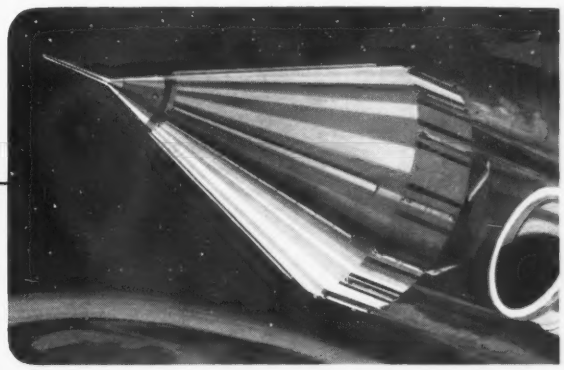


EXPLORER I... The United States' first successful earth satellite, launched January 31, 1958, was developed by JPL in collaboration with the Army Ballistic Missile Agency.



THE WAC-CORPORAL... fired in flight from a V-2 rocket, established a world's altitude record of 250 miles in 1949. The combination was known as the Bumper-Wac.

THE SERGEANT... A second-generation solid propellant missile developed by JPL for the U.S. Army. The SERGEANT is now being readied for production.



PIONEER IV... America's first successful moon-space probe, launched March 3, 1959, was developed by the Jet Propulsion Laboratory in collaboration with the Army Ballistic Missile Agency and the National Aeronautics and Space Administration.

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY

JET PROPULSION LABORATORY

A Research Facility operated for the National Aeronautics and Space Administration

PASADENA, CALIFORNIA

Employment opportunities for Engineers and Scientists interested in basic and applied research in these fields:

INFRA-RED, OPTICS, MICROWAVE, SERVOMECHANISMS, COMPUTERS, LIQUID AND SOLID PROPULSION, STRUCTURES, CHEMISTRY, INSTRUMENTATION, MATHEMATICS, AND SOLID STATE PHYSICS

Send professional resume', with full qualifications and experience, for our immediate consideration

plasmas, $52,000, **Leland Stanford Jr. Univ.**, Stanford, Calif.

Aspan (Nike-Asp) rocket vehicles, less Nike booster and Nike fins, $43,930, **Cooper Development Corp.**, 2626 S. Peck Rd., Monrovia, Calif.

Study of a vehicle which would derive its propulsive energy directly from the sun as solar radiation, $50,000, **Rensselaer Polytechnic Institute,** Troy, N.Y.

A four body, three-dimensional study of lunar trajectories, $30,462, Missile and Space Vehicle Dept., **General Electric Co.**, 3198 Chestnut St., Philadelphia, Pa.

Recorder/reproducer, magnetic tape, $27,486, **Ampex Corp.**, 392 Centre St., Newton, Mass.

AF Flight Test Center, ARDC, USAF, Edwards AFB, Calif.

Determine suitability of refractory materials for deflecting rocket exhaust gases, $249,658, **Marquardt Aircraft,** 16555 Saticoy Ave., Van Nuys, Calif.

Liquid-rocket track vehicle thrust selector system, $25,289, **Aerojet-General Corp.**, P.O. Box 1947, Sacramento, Calif.

Engineering and design of Mach 3 sled-pusher, $42,290, **Aircraft Armaments,** Cockeysville, Md.

AF Office of Scientific Research, Washington 25, D.C.

Continuation of research on hypersonic flow by means of a shock tunnel, $139,954, **Cornell Aeronautical Lab,** 4445 Genesee St., Buffalo 21, N.Y.

Research on turbulence, $53,500, **Univ. of Maryland,** College Park, Md.

Research on magnetohydrodynamic waves, $49,186, **Aeronutronic Systems,** 1234 Air Way, Glendale, Calif.

Heavy particle propulsion research, $150,134, **Reaction Motors,** Denville, N.J.

Research on heat transfer in a plasma, $26,000, **MIT,** Cambridge 39, Mass.

Theoretical and experimental maser research, $72,600, **Leland Stanford Jr. Univ.**, Stanford, Calif.

Continuation of research on physical properties of metals and alloys at elevated temperatures, $91,000, **CalTech,** Pasadena, Calif.

ARMY

Army Ordnance District, Los Angeles, 55 S. Grand Ave., Pasadena, Calif.

Target missile, $25,686, **Ryan Aeronautical,** Lindbergh Field, San Diego 12, Calif.

Warhead, $390,000, **Rheem Mfg.**, 9236 E. Hall Rd., Downey, Calif.

Guided missile, $150,879, **Douglas Aircraft,** 3000 Ocean Park Blvd., Santa Monica, Calif.

Guided missile, $900,000, **Firestone Tire & Rubber,** 2525 Firestone Blvd., Los Angeles 54, Calif.

Telemetry sets, $31,910, **Motorola,** 8201 East McDowell Rd., Phoenix, Ariz.

Design and development, $1,073,000, **North American Aviation,** 6633 Canoga Ave., Canoga Park, Calif.

Computer Systems, $39,799, **Servomechanisms, Inc.**, 12500 Aviation Blvd., Hawthorne. Calif.

Research and development, $2,390,000, **CalTech,** 1201 E. California St., Pasadena, Calif.

Boston Ordnance District, Army Base, Boston 10, Mass.

R&D study, $50,000 **Geophysics Corp. of America,** Boston, Mass.

High-altitude platforms study, $243,793, **Raytheon,** Waltham, Mass.

New York Ordnance Dist., 770 Broadway, New York 3, N.Y.

Design, develop, fabricate, and test parachute recovery system for the Redstone booster, $99,638, **M. Steinthal & Co.**, Aeronautical Equipment Research Corp. Div., 222 Fourth Ave., New York 3, N.Y.

Purchasing and Contracting Div., White Sands Missile Range, N.M.

Telemetry system, $49,850, **Spectralab Instruments,** 608 Figulio Ave., Monrovia, Calif.

Decom systems, $79,110, **Data Instruments Div., Telecomputing Corp.**, 12838 Saticoy St., N. Hollywood, Calif.

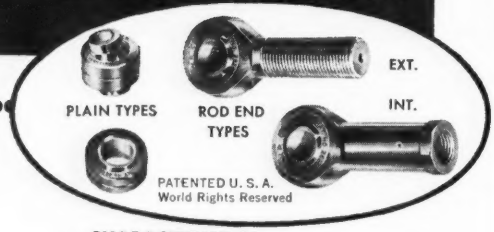
Loki meteorological rockets, $70,646, **Cooper Development Corp.**, 2626 S. Peck Rd., Monrovia, Calif.

Super Loki rockets, $39,650, **Aeronutronic Systems,** 1234 Air Way, Glendale 1, Calif.

NAVY

Dept of the Navy, Bureau of Aeronautics, Washington 25, D.C.

SOUTHWEST
"Monoball"®
SELF-ALIGNING BEARINGS



CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for Engineering Manual No. 551. Address Dept. AST-59

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

RESEARCH ENGINEERS

Challenging positions are available in research for men with B.S. to M.S. degrees in Mechanical Engineering, Chemical Engineering, or Aeronautical Engineering with experience in the fields of rocket propulsion, ballistics, and case design.

We offer you an opportunity to use your initiative and creative ability in an atmosphere conducive to accomplishment. These positions afford association with some of the leading engineers in this field.

Excellent employee benefits including liberal vacation policy and tuition free graduate study. Please send resume to:

E. P. Bloch
ARMOUR RESEARCH FOUNDATION of
Illinois Institute of Technology
10 West 35th Street
Chicago 16, Illinois

Plan and conduct wind tunnel investigation program and formulate a method of determining aerodynamic loads, $36,891, **Temco Aircraft Corp.**, Dallas, Tex.

Conduct a buffet research program, $86,233, **North American Aviation**, Columbus 16, Ohio.

Research and development of integrated flight capsule design for F3U-1 aircraft, $1,055,701, **Chance Vought Aircraft**, Dallas, Tex.

Dept. of the Navy, Bureau of Ships, Washington 25, D.C.

Design, construct, and furnish a full-scale model of a jet engine test platform, $81,600, **Goodyear Tire & Rubber**, 1144 Market St., Akron 16, Ohio.

Naval Air Material Center, Naval Base, Philadelphia 12, Pa.

Bullpup design information presentation, consisting of the preparation and presentation of a series of lectures on the Bullpup guided missile weapon system, augmented and supplemented and appropriate visual aids, including slides, charts, and the showing of government furnished and contractor owned colored sound movies, $27,908, **The Martin Co.**, Orlando, Fla.

Office of Naval Research, Washington 25, D. C.

Research on high-powered transducers, $25,000, **Illinois Institute of Technology**, Chicago, Ill.

Research on defense against ballistics missiles, $117,783, **Hughes Aircraft**, Culver City, Calif.

Research on defense against ballistics missiles, $121,061, **Allied Research Associates**, Boston, Mass.

Research on defense against ballistics missiles, $166,347, **General Electric**, Syracuse, N.Y.

Research on high-altitude equatorial flight, $25,041, **Winzen Research**, Minneapolis, Minn.

Research on defense against ballistic missiles, $96,225, **Univ. of Chicago**, Chicago, Ill.

Research on defense against ballistic missiles, $143,007, **Aeronutronic Systems**, Glendale, Calif.

Research on ballistic missiles defense, $128,079, **Convair**, San Diego, Calif.

Research and development of magnetic core memory, $182,500, **Telemeter Magnetics**, Los Angeles, Calif.

Research on the pressure fluctuations in a turbulent boundary layer, $34,400, **Univ. of Michigan**, Ann Arbor, Mich.

Design, manufacture, and evaluation of rocketborne ionosphere antennas, housing units, and antenna opening mechanisms, $49,929, **Raymond Engineering Lab.**, Middletown, Conn.

Design, develop, and furnish ultrahigh vacuum gauges for satellite instrumentation, $87,000, **MRC Equipment Corp.**, Newton Highlands, Mass.

Development and fabrication of flight instrumentation assemblies, $140,050, **Cooper Development Corp.**, Monrovia, Calif.

Ideas for missile engineers

Hackney components—deep drawn shapes, shells and parts—offer designers many advantages, including:

- **great strength with minimum weight**
- **elimination of heavy castings, forgings, etc.**
- **maintenance of exact diameters, wall thicknesses**
- **simplification of assemblies to speed installations**
- **naturally smooth surfaces which are easy to paint, clean, maintain**
- **making parts in ten different metals**
- **maximum latitude in designing; for example, wall thicknesses .050" to .700"...working pressures to 6000 psi...as well as ample design latitude in capacities, diameters and depths**

For engineering facts, data on components already produced by Hackney engineers for missile and rocket projects, write to the address below.

Pressed Steel Tank Company

Manufacturer of Hackney Products Since 1902

1476 South 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

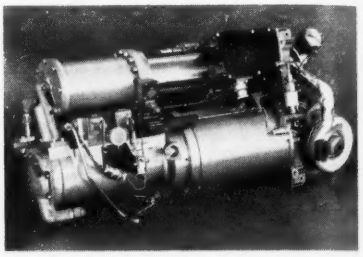
New equipment and processes

New Steel-Like Material: An experimental material, CentraSteel, offers replacement for plain steel forgings and permits design flexibility of castings. The material has a 28 million psi elastic modulus, nearly equal to steel, plus equivalent strength and improved machinability. It requires no extensive heat treatment, explosive or costly addition agents, or injection apparatus. General Motors Central Foundry Div., General Motors Corp., Detroit 2, Mich.

Nitrile Silicone Rubber Stock: NSR-X5602 is intended for intermittent contact with high swell fluids or continuous immersion in milder fluids. It is a 60-durometer, relatively low modulus stock for seals, boots, diaphragms, and shock mounts. The material can be fabricated by extrusion, molding, or calendering. General Electric Co., Silicon Products Dept., Waterford, N.Y.

Rubber Impellers: Flexible impellers for self-priming pumps are available in sizes suitable for pumping capacities from $^1/_2$ to 120 gpm, operating at speeds from 300 through 6000 rpm. Compounds of Neoprene and Hycar are adaptable to handling a variety of liquids at temperatures from 40 to 175 F. Pacific Moulded Products Co., 905 E. 59 St., Los Angeles 1, Calif.

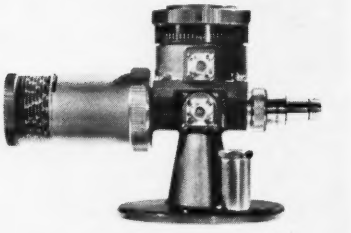
Auxiliary Power Unit: Designed for missiles, and operating on ethylene oxide, a new APU supplies 5 hp for



7.5 min at specific load schedule. Its altitude range is from sea level to more than 100,000 ft. Components include a squib starter, hydraulic pump, accumulator, reservoir, fuel tank, manifold valve, alternator, speed control, and turbine drive unit. AiResearch Mfg. Div., The Garrett Corp., 9851 Sepulveda Blvd., Los Angeles 45, Calif.

Moisture Measurement: CEC Moisture Monitor measures and gives continuous readout of quantity of water in many liquids to 1 part per million. An important application is in monitoring jet fuel, since water dissolved in the fuel can freeze at high altitude. The analyzer unit mounts in an explosive-proof housing. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Standing Wave Detector: Type 219 standing wave detector permits direct reading of angle of reflection coef-



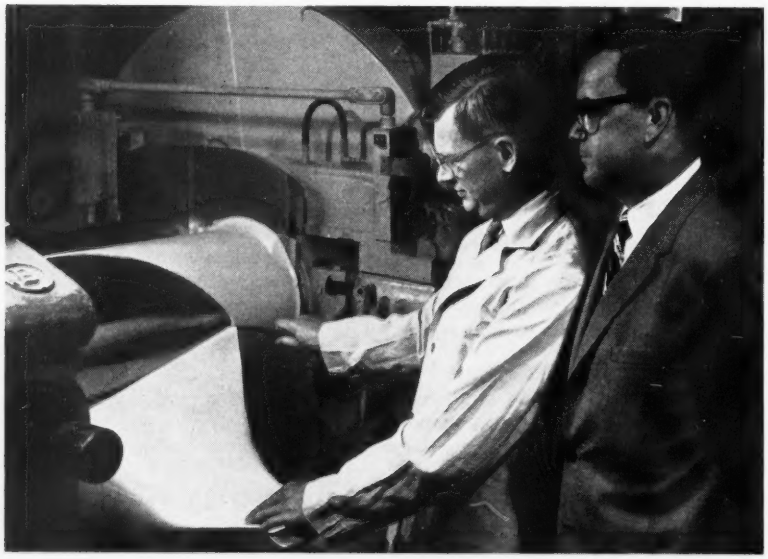
ficient, and measures impedance and VSWR from 100–1000 mc/sec. Residual VSWR less than 1.03; minimum input signal, approximately 1 v at 100 mc/sec; 0.1 v at 1000 mc/sec for measuring a matched load; characteristic impedance, 50 ohms. Polytechnic Research & Development Co., Inc., Brooklyn, N.Y.

Versatile Silicones

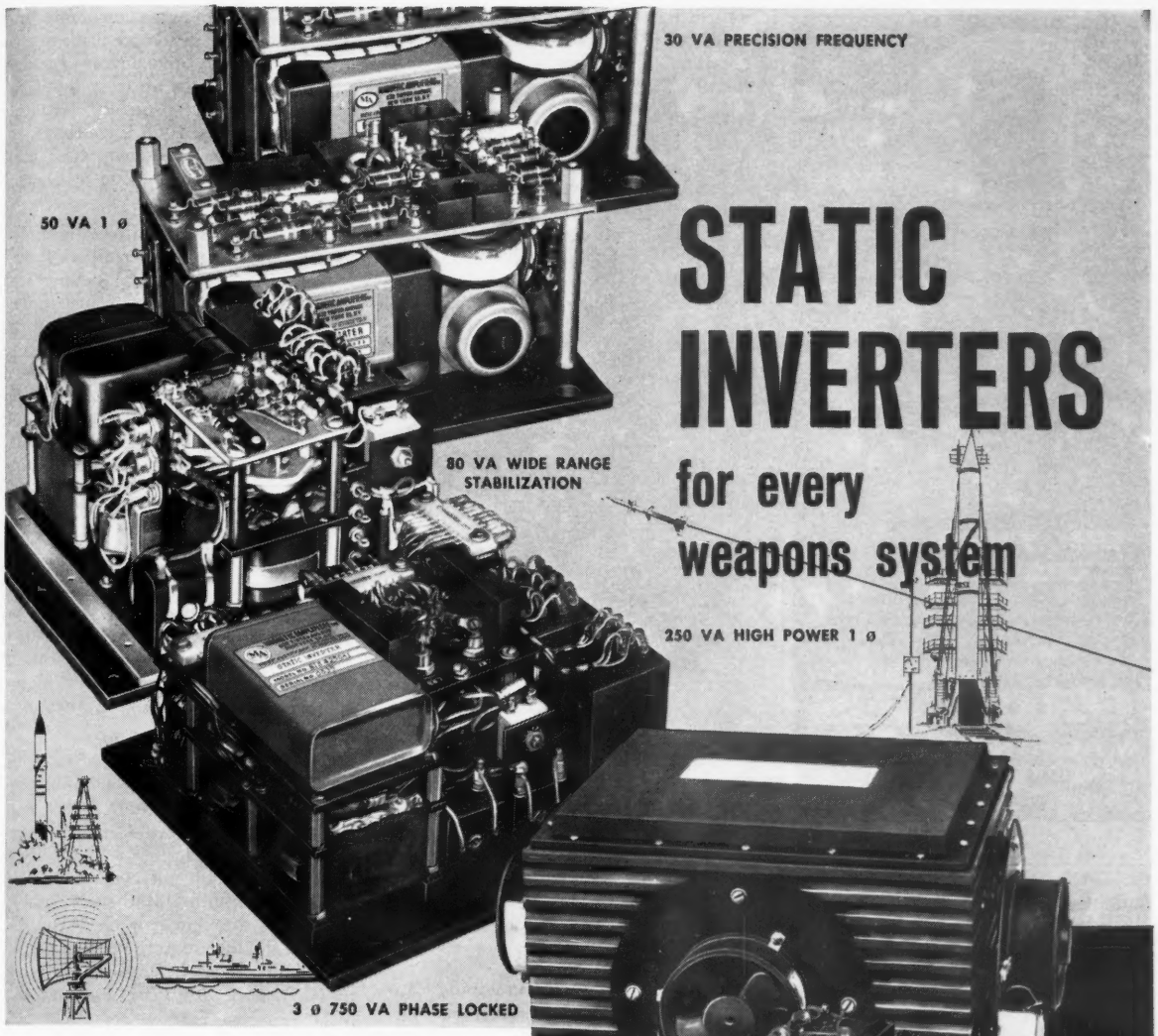
As silicones have gained wider acceptance and use, following the lead of the aerospace industries, a need has grown for more versatility in the compounding and forming of silicones with specific properties. Dow Corning Corp. has now provided an economical means for this versatility by introducing master batches of its basic formulations that can be tailored to needs of both the design engineer and manufacturer—that is, filled to give desired physical properties and finish, colored for parts and wire coding, and shaped by the local manufacturer to the specific tested model proposed by the engineer to meet his needs. The new master batches, moreover, offer improved processing properties for all conventional methods of manufacture, e.g., molding, extrusion, calendering, and dispersion coating. For instance, they have high green strength and feed easily into an extruder.

Of special interest to rocket and missile designers will be the new formulation LS-422, a fuel- and solvent-resistant fluorosilicone polymer reinforced with silica filler which gives low swell and which will accept additional filler for up to Shore A hardness.

Dow Corning silicones are identified by the trade name Silastic. Specs for the new master batches, and for the range of properties of LS-422, are available from Dow Corning Corp., Midland, Mich., Attn. R. S. Argyle.



Compounds made from new Silastic master batches strip easily from mill without use of a scraper blade.



STATIC INVERTERS

for every weapons system

With Magnetic Amplifiers, Inc.

SOLID STATE ELECTRONIC DESIGN

The complexity of the modern weapons system and the strategic importance of *no failures* in time of crisis has caused more and more Military Equipment manufacturers to include Magnetic Amplifiers, Inc. power units in their weapons system.

From our ranging Nuclear Submarine Fleet to ground base guidance and tracking systems to Aircraft and missiles . . . Magnetic Amplifiers, Inc., products are performing with precision and reliability.

Inquiries are invited concerning your power requirements. Engineering conferences can be arranged at your or our facilities. . . . Write, call or wire.

MA

MAGNETIC AMPLIFIERS, INC.

632 TINTON AVENUE
NEW YORK 55, N. Y.
CYPRESS 2-6610

136 WASHINGTON STREET
EL SEGUNDO, CALIFORNIA
OREGON 8-2665

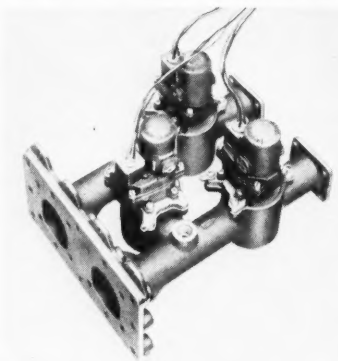
FROM THIS
Dimensions (nominal)
Dia. 9⅞" Ht. 12¾"
Mat'l. 0.035 Steel
TO THIS
Dimensions (nominal)
Dia. (top) 15" Ht. 11"
WITH
GROTNES EXPANDERS
Low-cost tooling. Extremely close dimensional tolerances. No Machining. No Waste. For information, see Sweet's Catalog, or write direct. Dept. A-11
GROTNES
MACHINE WORKS
5454 NORTH WOLCOTT AVENUE
Chicago 40, Ill., Phone: LOngbeach 1-7693

Radiation Testing: Environmental test cabinets, developed for investigation of the effect of high-temperature radiation, operate with a combination of water- and air-cooled condensers. Specimens, such as rubbers, plastics, and other elastomers, store in its concave door as well as in the main area. Hudson Bay Co., Div. of Labline, Inc., 3070–82 W. Grand Ave., Chicago 22, Ill.

Telemetry Antenna: TACA G-1054 design, used in the reception of information from orbital transmitters, allows a choice of helical feeds and parabolic reflectors, and has a manually controlled mount for ground or vehicle installation. Frequency range is 940 to 980 mc. A balanced antenna permits easy and accurate manual orientation. Technical Appliance Corp., Box 38, Sherburne, N.Y.

Airborne Magnetic Recorder: Developed for lunar probes, manned and unmanned spacecraft, and interplanetary vehicles, the AMR-100 can record and store data during long intervals and transmit it at an accelerated rate on a command signal. Weight, 8 lb; power requirements, 10 w. Lockheed Missiles Systems Div., Palo Alto, Calif.

Fuel Control System: This "package" fuel control system, developed for the Northrop T-38 supersonic trainer, consists of three motor-driven rotary-plug



shutoff valves incorporated in a manifold. All valves are in one bay, simplifying inspection and maintenance. Repairs can be made without removing fuels from lines or tanks. General Controls Co., 801 Allen Ave., Glendale 1, Calif.

Honeycomb Structure Machining: In the Anocut process for high-speed machining of stainless steel and aluminum honeycomb core, a series of sparks of short duration removes metal as to cut. A metallic wheel, having on its working surface a number of grooves each wide enough to assure extinction of the arc passed between the wheel and the honeycomb foil, gives 2500 contacts per sec for removing metal foil of the structure. Anocut Engineering Co., 631 W. Washington Blvd., Chicago 6, Ill.

Nuclear Batteries: Output potentials greater than 5 kv in a volume less than $^1/_4$ cu in. are available from a 1 oz battery which converts nuclear energy directly to electrical energy. The battery, based on radioisotope Krypton 85 (hence hazardous only if unshielded), has a useful life of approximately 10 years. Radiation Research Corp., 1114 First Ave., New York 21, N.Y.

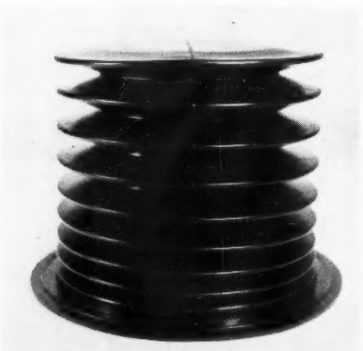
Differential Transformers: Available for evaluation, high-temperature transformers Types 6208 HHK and 6206 HHK are wound on ceramic bobbins, have leads terminated on lugs, and have fish-spline insulated leads up to 3 ft long. They give linear-displacement measurements up to ± 0.050 in. and ± 0.500 in., respectively. Operating temperatures, 1000 F continuously and 2000 F for periods up to 5 min. Automatic Timing & Controls, Inc., King of Prussia, Pa.

Bellows for Instrumentation: Hydraulic cold working gives resiliency and long service life to metal bellows for missile and other precision instrumentation. The bellows, of single-ply or multiple-ply construction and many different heads and sizes, have been made of phosphor bronze, beryllium copper, stainless steel, and morel. Bendix Aviation Corp., Hamilton Div., 5th St. & Ford Blvd., Hamilton, Ohio.

Gas Pressure Regulators: Giving dynamic response of better than 0.09 sec with precise control, these gas-pressure regulators handle large flow rates at pressure differentials as low as 50 psi. One unit can operate at 300 psi over an inlet pressure of from 3000 to 400 psi, and a flow-demand change of 140 to 640 SCFM of nitrogen. Thiokol Chemical Corp., Reaction Motors Div., Denville, N.J.

Nozzles and Adapters: Self-sealing, high-flow-rate hydrogen peroxide nozzles and adapters for servicing aircraft or missiles are available in sizes from $1^1/_2$ to 6 in. Working parts are fitted externally and do not come into contact with the fluid. Method of attachment into the line can be varied to meet individual requirements. Flight Refueling, Inc., Friendship International Airport, Box 1701, Baltimore 3, Md.

Molded Conductive Rubber: Difficult parts, such as bellows, may now be molded of a conductive rubber which dissipates high-voltage static to ground. Various polymers are com-

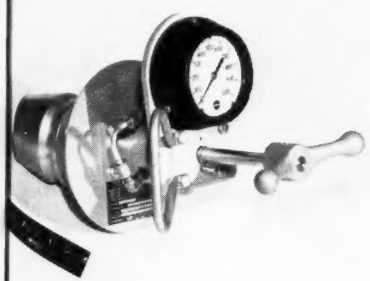


pounded for applications in fuel systems. The rubber compounds cannot carry a high electric current, and they resist many organic fluids, ozone, and weather. Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif.

Hand Loader Pressure Regulator: A simple pressure regulator, designed for missile ground support test equipment, flight units, laboratory and production testing, adjusts from 3000 psig regulated pressure to zero. Flow area, 0.003 in. squared when fully open; temperature range, −65 to 160 F. Clary Dynamics, 408 Junipero St., San Gabriel, Calif.

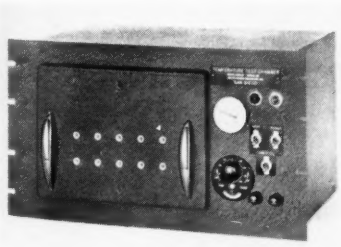
Flexible Plastic Conduit: Aircon 1010 J laminated plastic tubing for missiles and electronic cabling is lighter than aluminum, its walls (0.045 in. thick) are smooth inside and out, and it is resistant to flame, abrasives, ozone, etc. Graduated sizes, with offshoots suitable for harness systems made to specifications; can be completely waterproof. Airconductors, 367 E. Olive St., Gardena, Calif.

Coupling Tester: Portable MA-2 pull-off tester is used for rapid ground checking of engaging and disengaging forces between aerial refueling equipment. The instrument is inserted into the reception coupling to check the toggle tension and pull-off load forces.



Forces register on a gauge through a closed hydraulic circuit. Flight Refueling, Inc., Box 1701, Friendship International Airport, Baltimore 3, Md.

Rack-Mounted Temperature Chamber: Test chamber Model 6545 R has a test volume of 10 by 7 by 7 in. A direct-reading thermostat automatically controls temperature within ± 2 F between −100 and 500 F. The unit operates on 117 v AC, and incorporates a centrifugal blower to assure temperature uniformity. Delta Design Engineers, Inc., 7460 Girard Ave., La Jolla, Calif.



Versatile Motion Picture Cameras: Dual requirements are met in the latest 16-mm and 35-mm Mitchell motion picture cameras. They can be used on radars, tracking camera mounts, photogrammetric mounts, and fixed tripods to record missile and rocket development data. The same cameras may also be used for all standard cinematography. Operation is at speeds from "stop motion" to 128 frames per sec. Mitchell Camera Corp., 666 W. Harvard St., Glendale, Calif.

Electronic Speed Control: Laboratory and production testing can be conducted on a run-break-run basis by adding a new speed control to centrifuge acceleration test machines. The control is designed for Models RCT-1 and RCT-2, which offer electronic programing, sequencing, and remote operation. A single digital setting of the control establishes the desired speed range. The Rucker Co., 4706 San Pablo Ave., Oakland 8, Calif.

Automatic Printer for Weather Reports

Burroughs Display Device 501

Display Device 5401 prints electrostatically on paper tape incoming messages from standard telephone lines. It will also print from digital signals received from computers, punched paper tape, electronic message-storing devices, and magnetic drums. Designed to print out weather reports in plain language, the machine will be tested to determine its applicability to the worldwide weather observing and forecasting system being developed by the Air Force. A new message on local airfield weather observation can be displayed in less than 2 sec. Burroughs Corp., Detroit.

LITERATURE

Multiplier phototubes. Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N.J.

Precision potentiometers. Markite Corp., 155 Waverly Place, Dept. 58, New York 14, N.Y.

Switches and actuators. Electrosnap Corp., Switch Div., 4218 W. Lake St., Chicago 24, Ill.

Lighted display and pushbutton switch devices. Micro Switch, A Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Ohmite variable transformers. Ohmite Mfg. Co., 3601 Howard St., Skokie, Ill.

Single-turn precision potentiometers. Beckman/Helipot, Helipot Div. of Beckman Instruments, Inc., Fullerton, Calif.

Electronic tubes catalog. Sperry Electronic Tubes, Sperry Rand Corp., Great Neck, N.Y.

Miniature rectangular power connectors. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N.Y.

High precision potentiometers. DeJur-Amsco Corp., Long Island City 1, N.Y.

Solenoid valves. Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis 25, Ind.

Miniature electrical connectors. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

Index to Advertisers

Adel Precision Products 18
Otero & Winters, Inc., Los Angeles, Calif.

Aerojet General Corp. ..... **Back Cover**
D'Arcy Adv. Agency Co., Los Angeles, Calif.

Aeronutronic Systems, Inc. 86
Honig-Cooper, Harrington & Miner, Los Angles, Calif.

Amphenol Electronics Corp. 71, 72
Burton Browne Advertising, Chicago, Ill.

Arma Div., American Bosch Arma Corp. 79
Doyle, Kitchen & McCormick, Inc., New York, N.Y.

Armour Research Foundation of Illinois Institute of Technology 92, 98

Boeing Airplane Co. 76, 82
Fletcher Richards, Calkins & Holden, Inc., Seattle, Wash.

Bourns, Inc. 87
Allen, Dorsey & Hatfield, Inc., Los Angeles, Calif.

Callery Chemical Co. 68
Ketchum, MacLeod & Grove, Inc., Pittsburgh, Pa.

Chiksan Co., A Subsidiary of Food Machinery & Chemical Corp. 84
The McCarty Co., Los Angeles, Calif.

Chrysler Corp. 74

Consolidated Electrodynamics Corp. 15
Hixson & Jorgensen, Inc., Los Angeles, Calif.

Cooper Development Corp. 16
Allen, Dorsey & Hatfield, Inc., Los Angeles, Calif.

Douglas Aircraft Co., Inc. 43
J. Walter Thompson Co., Los Angeles, Calif.

Dynametrics Corp. 5
L. K. Frank Co., Boston, Mass.

Eastman Kodak Co. 41
The Rumrill Co., Inc., Rochester, N.Y.

Elastic Stop Nut Corp. 7
G. M. Basford Co., New York, N.Y.

The Garrett Corp., AiResearch Mfg. Div. 9
J. Walter Thompson Co., Los Angeles, Calif.

General Electric Co., Defense Systems Dept. 81
Deutsch & Shea, Inc., New York, N.Y.

General Electric Co., Flight Propulsion Laboratory Dept. 11
G. M. Basford Co., New York, N.Y.

General Electric Co., Silicone Products Dept. 91
Brooke, Smith, French & Dorrance, Inc., New York, N.Y.

General Electric Co., Heavy Military Electronics Dept. 95
Deutsch & Shea, Inc., New York, N.Y.

General Precision Laboratory, Inc. 89
Gaynor & Ducas, Inc., New York, N.Y.

Grotnes Machine Works 102
The Gerstel Agency, Chicago, Ill.

Haveg Industries, Inc. 67
Photo Art Advertising, Wilmington, Del.

Hughes Aircraft Co. 59
Foote, Cone & Belding, Los Angeles, Calif.

Jet Propulsion Laboratory 97
Stebbins & Cochran Advertising, Los Angeles, Calif.

Johns Manville 2
J. Walter Thompson Co., New York, N.Y.

Lockheed Missiles & Space Div. 85
Hal Stebbins, Inc., Los Angeles, Calif.

Los Alamos Scientific Laboratory 48
Ward Hicks Advertising, Albuquerque, N.M.

Magnetic Amplifiers, Inc. 101
De Garmo, New York, N.Y.

The Marquardt Corp. 12–13
Grant Adv., Inc., Hollywood, Calif.

The Martin Co., Denver Div. 17
E. M. Halvorson Co., Denver, Colo.

Micro Switch, Div. of Minneapolis Honeywell 63
Reinecke, Meyer & Finn, Inc., Chicago, Ill.

Minneapolis Honeywell, Heiland Div. 46–47
Tool & Armstrong Adv., Denver, Colo.

Mosley Electronics, Inc. 93
H. George Bloch, Inc., St. Louis, Mo.

North American Aviation, Inc.
Los Angeles Engineering 73
Columbus Engineering 83
Batten, Barton, Durstine & Osborn, Inc., New York, N.Y.

Northrop Corp., Radioplane Div. 1
Erwin Wasey, Ruthrauff & Ryan, Inc., Los Angeles, Calif.

Nuclear Systems, Inc., A Div. of the Budd Co. 49
Lewis & Gilman, Inc., Philadelphia, Pa.

Pressed Steel Tank Co. 99
The Buchen Co., Chicago, Ill.

Reeves Instrument Corp. 61
Edward W. Robotham & Co., Westport, Conn.

Reeves Soundcraft Corp. ..... **3rd cover**
The Wexton Co., New York, N.Y.

Republic Aviation Corp. 57
Deutsch & Shea, Inc., New York, N.Y.

Robbins Aviation, Inc. 93

Rolle Mfg. Co. 69
The Harry P. Bridge Co., Philadelphia, Pa.

The Singer Mfg. Co. 65
O. S. Tyson & Co., Inc., New York, N.Y.

Southwest Products Co. 98
O. K. Fagan Adv. Agency, Los Angeles, Calif.

Stephens-Adamson Mfg. Co. 10
Connor Associates, Inc., Aurora, Ill.

Technical Appliance Corp. 92
Lescarboura Adv., Inc., Ossining, N.Y.

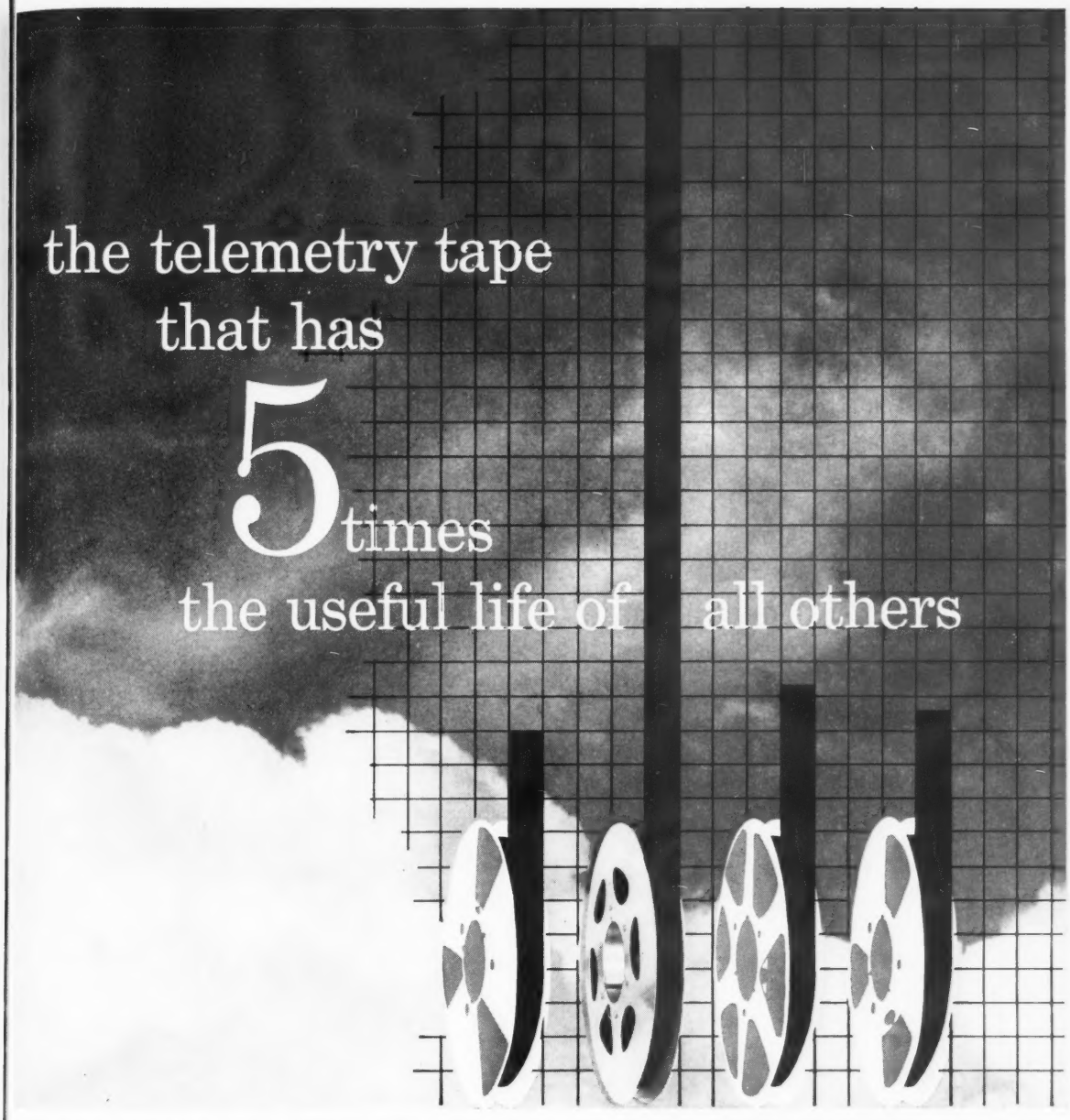
Telecomputing Corp., Whittaker Controls Div. 45
Anderson-McConnell Adv. Agency, Inc., Hollywood, Calif.

H. I. Thompson Fiber Glass Co. ..... **2nd Cover**
Van der Boom, Hunt, McNaughton, Inc., Los Angeles, Calif.

Thompson Ramo Wooldridge Inc., Tapco Group 51–54
Meldrum & Fewsmith, Inc., Cleveland, Ohio

Vinco Corp. 75
Rolfe C. Spinning, Inc., Royal Oak, Mich.

Westinghouse Electric Corp. 77
H. W. Buddemeier Co., Inc., Baltimore, Md.



SOUNDCRAFT TYPE B TELEMETRY TAPE!

Most tapes used for telemetering begin to break down after a comparatively few number of passes through the tape transport. But actual field applications prove that SOUNDCRAFT Type B Tape performs reliably throughout a life span of at least 5 to 1 over competitive tapes!

Only SOUNDCRAFT has combined all characteristics specifically needed for flawless carrier-type recording into a single tape. Only SOUNDCRAFT Type B Tape is MICROPOLISHED (Pat. #2-688567) to provide a mirror-smooth, defect-free surface...the most durable low-friction surface among all tapes today! And only SOUNDCRAFT applies the oxide formulation to a pre-coated base by means of the exclusive Uni-level coating process, to assure an even, uniform coating thickness. As a result, the output of SOUNDCRAFT Type B Tape is completely uniform—throughout the entire life of the tape. Furthermore, the tape flows more freely over recording heads with a uniformity of motion which insures faithful reproduction of carrier frequencies.

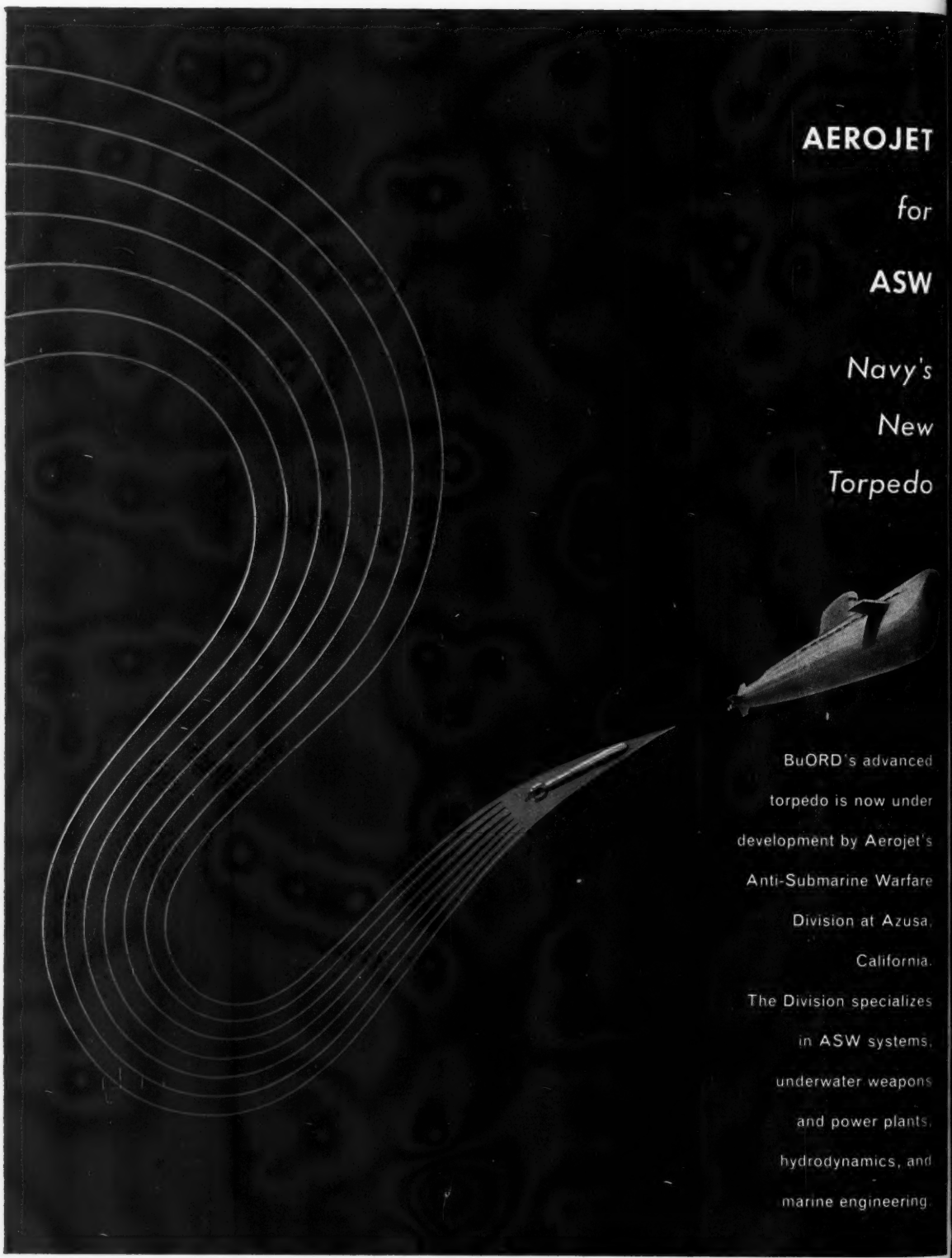
So, for your carrier-type recording, specify the only tape designed specifically for telemetering—the tape that offers dependable performance PLUS five times the useful life of other telemetry tapes—SOUNDCRAFT TYPE B TAPE! Write today for free brochure.

REEVES SOUNDCRAFT CORP.

Great Pasture Road, Danbury, Connecticut • West Coast: 342 N. La Brea, Los Angeles 36, California • Canada: 700 Weston Road, Toronto 9, Ontario

AEROJET for ASW

Navy's New Torpedo



BuORD's advanced torpedo is now under development by Aerojet's Anti-Submarine Warfare Division at Azusa, California. The Division specializes in ASW systems, underwater weapons and power plants, hydrodynamics, and marine engineering.

AEROJET-GENERAL CORP®

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

AUG 4